nitoring and Mitigation Project

986 Annual Progress Report

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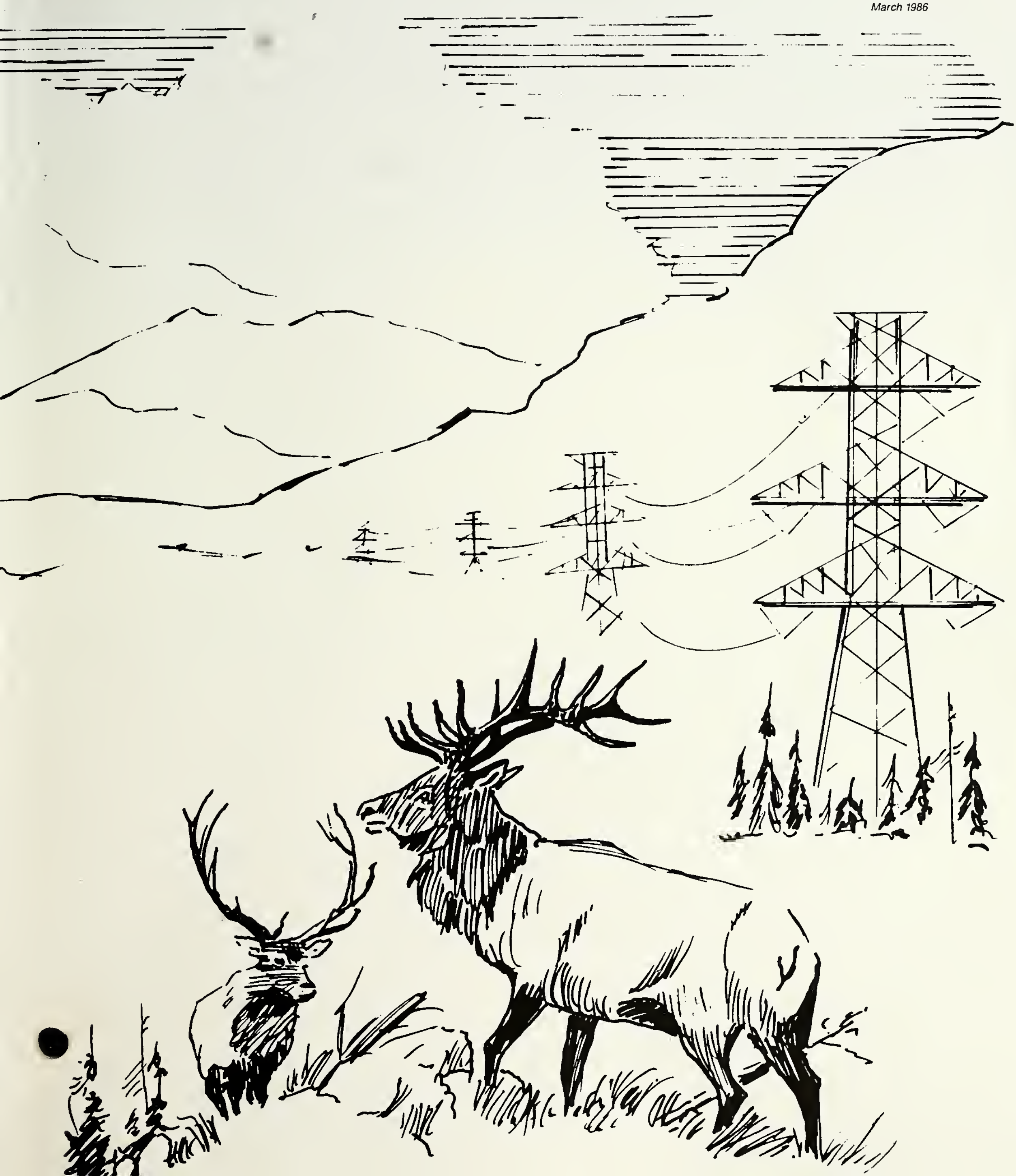

Impact Mitigation and Monitoring of the BPA
500 KV Garrison-Taft Transmission Line--
Effects on Elk Security and Hunter Opportunity

Annual Progress Report for 1986

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These approvals pertain to the technical content of this report. They are not intended to imply endorsement of the preliminary recommendations in this progress report.

June 1987

ACKNOWLEDGEMENT

This study required the efforts, assistance, cooperation, and support of numerous individuals in the Montana Department of Fish, Wildlife and Parks (DFWP) and the other involved agencies. Funding was provided by the Bonneville Power Administration (BPA). Supplemental funding for yearlong relocation efforts in the DeBorgia area and elk capture efforts in both study areas was provided by DFWP (principally through cost-sharing with the Lower Clark Fork Elk Project). Additional funding for travel expenses and relocation efforts was provided by the Rocky Mountain Elk Foundation. Supplemental funding for fall relocation efforts in the DeBorgia area was provided by the Lolo National Forest (LNF).

The Montana Department of Natural Resources and Conservation (DNRC), DFWP, BPA, LNF, Deerlodge National Forest, and U. S. Bureau of Land Management all participated in ongoing project planning and review. The "Introduction" section of this report was taken from the project's study plan which was drafted by Gary Hammond and Larry Thompson. The University of Montana, Cooperative Wildlife Research Unit, and Intermountain Forest and Range Experiment Station, all located in Missoula, provided equipment and expertise. Aviation services were provided by Dave Rosenkranz and Bill Stewart of Hamilton Aviation and Pete Johnson of DFWP. Special thanks are extended to Bruce Sterling for field assistance provided during the month of June; to Sharon Rose for assistance with typing, editing, and drafting; to Quinn Prichard for graciously donating the cover artwork; and to Jodie Canfield for comments on an earlier draft which were incorporated in this report.

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INTRODUCTION

Background

In November of 1982, a joint state-federal study team selected the Taft South Route for the Bonneville Power Administration's (BPA) Garrison West powerline project ("the Project"). The agencies were concerned with the potential wildlife impacts of the Taft South route because this route crossed many miles of what was considered to be important elk summer-fall habitat: high, moist, forested mountain slopes including large areas of land a mile or more from existing roads, some of which had been designated as roadless areas in the U. S. Forest Service (USFS) RARE II evaluation. The joint state-federal analysis of the alternative routes for the Project concluded that although this route would minimize impacts to people, it would pose the greatest risk of impact to fish, wildlife, and nonmotorized recreation.

The interagency study team concluded that an elk mitigation and monitoring study was necessary in part to document the various impacts on elk and, secondly, to mitigate for these impacts to the extent possible (U.S.D.O.E. et al. 1983). Predicted impacts included the following:

1. **Impacts due to Construction Activity:** The state's impact analysis determined that powerline construction activity would have impacts on elk populations similar to those documented for logging activities by the Montana Cooperative Elk-Logging Study (Lyon et al. 1985). The interagency study team concluded that it was not a worthwhile expenditure of resources to duplicate earlier study in an attempt to document these already well-known impacts. Also, the impacts of construction activity on elk populations, hunter opportunity, and hunting quality are short-term in comparison to other impacts and hence of lesser concern. Therefore, the study was not designed to document impacts due to construction activity.

2. **Impacts Due to Towers and Conductors:** The presence of towers and conductors would have a significant visual impact on the quality of the hunting experience, but would probably not affect hunter opportunity or elk populations.

3. Impacts Due to Electrical Effects and Noise: The effect of electrical fields and noise upon elk was not felt to be a major concern; however, the findings of the Boulder Elk Study indicated that there may be some response of elk to transmission line-related noise (Canfield 1984, Picton et al. 1985).

4. Impacts Due to Cleared Right-of-Way: The presence of a cleared right-of-way would have a slight effect on elk habitat quality--possibly a beneficial effect--but this would not be significant because the amount of habitat affected is relatively small and spread over a relatively great length of line. Some visual impacts due to the right-of-way would affect hunting quality, and some hunting access (in addition to that created by access roads) would be provided. But the impacts of the cleared right-of-way were not thought to be a major concern.

5. Impacts Due to New Access Roads: Of greatest concern were the impacts of new access roads created as part of the Project (including upgrading of existing low-quality roads to BPA standards). The Montana Department of Natural Resources and Conservation's (DNRC) draft response to the Board stated that:

> . . . research has shown that increased road densities in elk habitat could render animals more vulnerable to hunting. This commonly causes more restrictive hunting regulations in the form of shorter seasons or hunting by permit only. Shorter seasons and permit hunting are unpopular with hunters and could decrease revenues available for wildlife management and local economies in the form of license fees and recreational expenditures. Elk license revenues in 1978 totaled $4.4 million in Montana (Lonner and Cada 1982). A conservative estimate of elk hunter spending is $45 per day, which contributes an additional $29 million to the State's economy each hunting season (Montana Dept. of Natural Resources and Conservation 1983:34).

The primary long-term and direct impact on elk anticipated from the Project is the opening of previously-unroaded security areas to hunters by line access roads. This leads in turn to: (1) changes in elk distribution, (2) changes in habitat use patterns, (3) possible reduction in available security areas forcing animals into marginal habitats, (4) earlier harvest of

bulls leading to a reduction in hunter opportunity, (5) lower ratios of bulls to adult cow elk, and (6) more restrictive seasons or permit-only hunting because of the reduction in the availability of bulls left to hunt. Most of these predicted impacts are a result of the loss of secure summer-fall habitat in areas crossed by transmission line access roads, hence the emphasis of the study on elk summer-fall security areas.

A secondary long-term impact anticipated from the Project is the opening up to timber harvest of areas that would otherwise not have been logged for years (or perhaps never) because of marginal economics and lack of haul roads. This logging, in areas that would otherwise be untouched, would cause additional impacts to wildlife (Montana Dept. of Natural Resources and Conservation 1983:34).

Mitigation and Monitoring Plan

A plan for impact mitigation and monitoring was agreed upon by the Lolo National Forest, Deerlodge National Forest, U. S. Bureau of Land Management, DNRC, and BPA in 1983 (U.S.D.O.E. et al. 1983). Mitigation measures pertaining to anticipated impacts on elk populations and hunting generally were of 2 types: (1) those intended to avoid or minimize short-term construction disturbances of elk populations during critical times of the year, and (2) those intended to minimize or reduce anticipated long-term impacts.

Specific mitigation measures agreed upon at the Project's outset included: (1) timing restrictions (i.e., construction permitted only on a case-by-case basis from 1 December-15 May) on construction activities in 24 locations where the Project intersected elk winter-spring ranges, (2) timing restrictions (i.e., construction permitted only on a case-by-case basis from 15 March-15 July) on construction activities in 1 location where the Project intersected a known elk calving area, (3) seasonal or yearlong gated closures of new Project roads that intersected existing closed roads or provided access through previously unroaded habitats, (4) permanent closures or obliterations of roads not necessary for future management (most notably a 1/4-mile segment of the Harvey-Eightmile tie-through road to prohibit establishment of through traffic in previously unroaded elk habitat), and (5) participation by a

Study Plan

A study plan was developed by the interagency study team in 1984 which outlined tasks, methods, and schedules for meeting the study objectives. Specific tasks outlined in the study plan are:

1. Review literature.
2. Map vegetation and habitat types.
3. Develop analytical procedures and standard data forms.
4. Collect data along elk pellet-group transects.
5. Summarize elk hunting regulations and harvest data.
6. Assist with DNRC hunter opportunity study.
7. Install and monitor traffic counters.
8. Capture and collar elk.
9. Relocate radioed elk and map elk security areas.
10. Determine fecal DAPA levels.
11. Monitor construction and compliance with mitigation measures.
12. Participate in Forest Service project planning.
13. Participate in the Forest Service forest planning process.
14. Implement road closures through participation in the Forest Service travel planning process.
15. Determine project impacts on elk and hunting opportunity.
16. Determine magnitude of unmitigated impacts.
17. Recommend measures to offset unmitigated project impacts.
18. Prepare reports.

Tasks (including the final report) are scheduled for completion by 31 August 1988. Study areas were selected, and data were collected along pellet-group transects from August-October 1983, prior to powerline construction (Elliott 1983). Pre-construction hunter surveys also were accomplished in 1983 (Allen 1984). Study activities resumed in March 1984 when the project biologist was hired, and study progress has been summarized for the calendar years of 1984 and 1985 in 2 previous annual progress reports (Hammond et al. 1985, Thompson and Sterling 1986). This report summarizes study progress from January-December 1986.

STUDY AREAS

The powerline corridor is 156 miles long and extends between the Garrison and Taft substations in western Montana. About 75% of the land crossed by the powerline is public land administered by the USFS; the remainder is divided among private, corporate, state, and U. S. Bureau of Land Management administration. Construction of the powerline and road system began at a relatively low intensity in August 1983, but began in earnest in June 1984 (Fig. 1). Construction activities ended on 7 November 1985 with energization of the powerline.

Project impacts along the entire corridor are being monitored and evaluated, in part by extrapolating the results of intensive monitoring on 2 study areas located at opposite ends of the corridor (Fig. 2). These 2 study areas, referred to as Harvey-Eightmile and DeBorgia, represent the moisture- and cover-type extremes in summer-fall elk habitats that occur along the corridor. Both study areas are heavily forested and include previously-unroaded security areas that were crossed by the powerline corridor and associated new roads.

Harvey-Eightmile

The Harvey-Eightmile study area (Fig. 3) is located in Granite County, approximately 11 miles west of Hall, Montana. General boundaries are lower Harvey Creek on the east, Harvey-Eightmile ridge trail on the south, Strawberry Mountain on the west, and Tyler Mountain and Lodgepole Spring on the north. Two major stream drainages, Tyler Creek and Eightmile Creek, flow northeasterly through the area into the Clark Fork River. Prominent peaks in the region include Sliderock Mountain (7,820 ft or 2,383 m), Golden Mountain (6,634 ft or 2,022 m), and East Hill (6,150 ft or 1,874 m), all of which are located immediately west of the study area. Forests in the Pseudotsuga menziesii and Abies lasiocarpa series dominate the vegetation cover (Pfister el al. 1977).

The Harvey-Eightmile study area was divided into 2 separate zones for analysis purposes. The western half of the study area (sampled by transects #5-8) was previously roaded and includes a number of clearcuts; this was

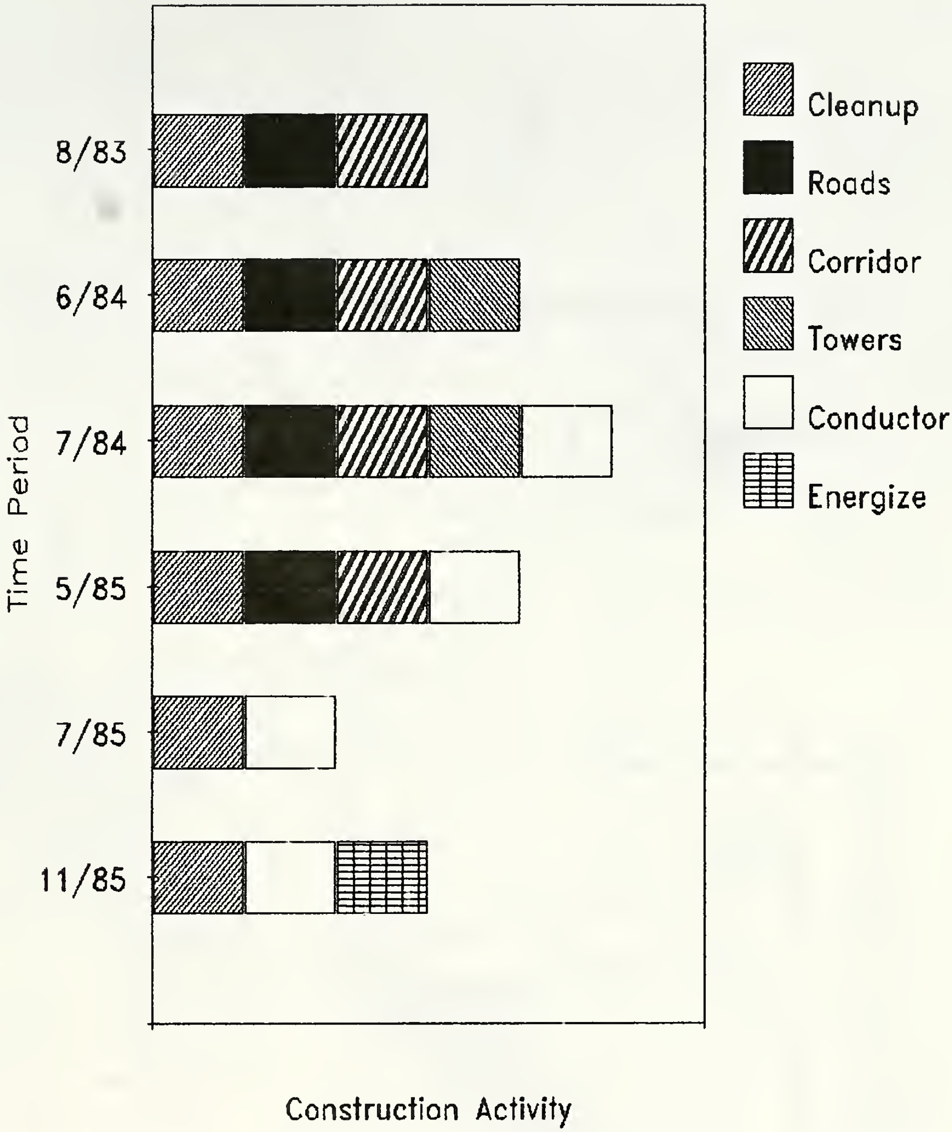


Fig. 1. Schedule of construction activities from August 1983–November 1985 on the Garrison-Taft powerline project in western Montana. Each date is a beginning or ending date for a particular construction activity. Each set of construction activities shown on a given date continued to the next date; major construction activities ended on 7 November 1985.

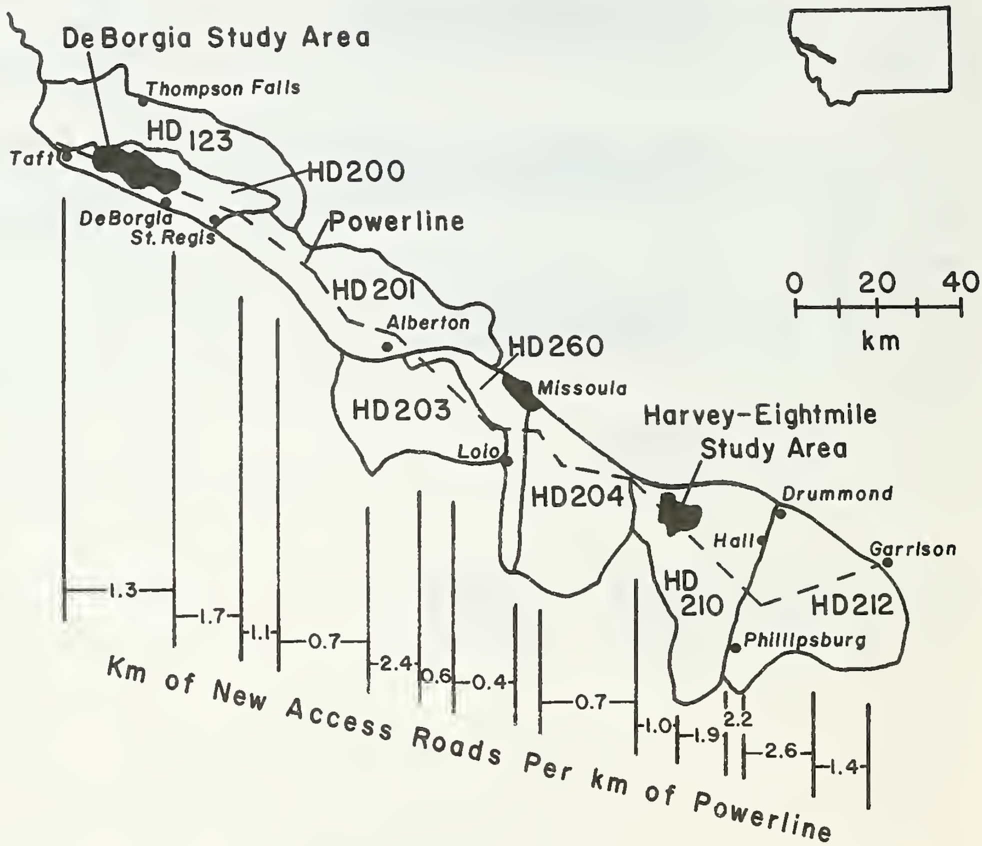


Fig. 2. Location of the Garrison-Taft powerline project and study areas relative to Montana elk hunting districts (HD) and towns, and the relative densities of new roads constructed for powerline project access in 13 segments of the powerline route.

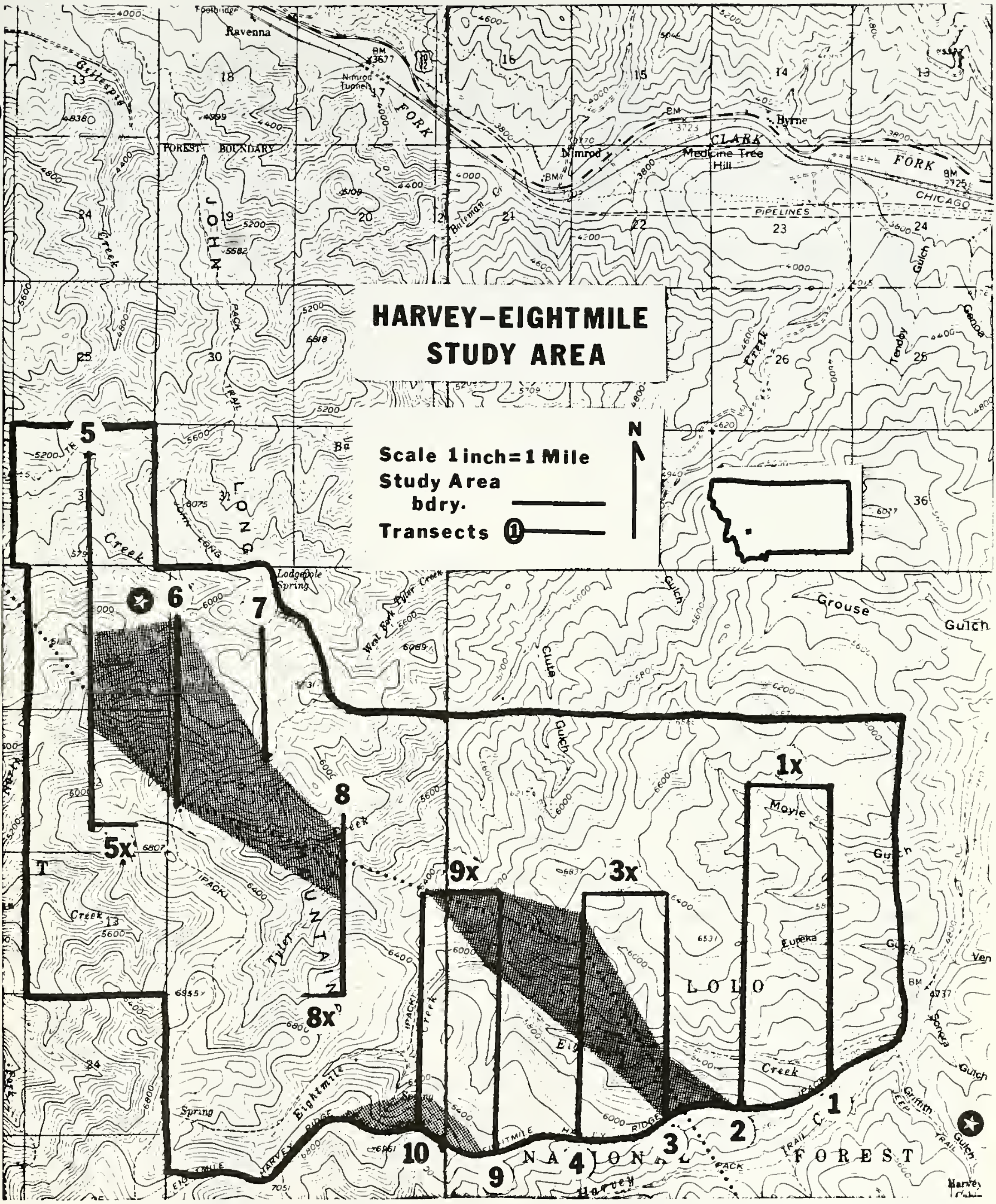


Fig. 3. Location of the Harvey-Eightmile study area, pellet transects, and traffic counters (stars) in relation to the BPA powerline (dotted line) near Hall, Montana. The shaded areas are powerline-influenced analysis units used to evaluate elk distribution (see pp 14-15).

referred to as the Cut-over study zone. Conversely, the eastern half of the study area (sampled by transects #1-4 and 9-10) was previously unroaded and not clearcut; this was referred to as the Uncut study zone.

In cooperation with this study, the USFS deferred the Harvey-Eightmile timber sale in the center of the Harvey-Eightmile study area for the duration of this study. Also, the USFS agreed to remove from consideration several blocks of the Brewster-Tyler-Genoa timber sale which would have impacted the study area. This will facilitate an analysis of powerline-related impacts without the confounding influences of logging activities.

DeBorgia

This study area is situated north of DeBorgia in Mineral County (Fig. 4), and is bounded by Hemlock Mountain on the west, Twelvemile Creek on the east, and the C-C Divide on the north, and extends southwardly to an area near the St. Regis River. From the C-C Divide at elevations of about 6,000 ft (1,828 m), the area slopes steeply to the south to about 4,000 ft (1,219 m) at the Osborne fault. South of this east-west line, the topography is rolling and divided by numerous small streams--the most prominent being Packer, McManus, Timber, Twin, Savenac, and Rock Creeks. Vegetation cover is dominated by forests in the Abies grandis series (Pfister et al. 1977).

The DeBorgia study area consists of two separate zones referred to as the Packer Creek zone (west) and the Middle Fork Rock Creek zone (east). The area situated between these two zones, from Timber Creek to the West Fork of Twin Creek, is included as a secondary study zone (Fig. 4). Study intensity is lower in this secondary zone than in the primary study zones due to a larger proportion of private ownership. Within this zone, all USFS activities are kept to a minimum and coordinated with this research effort.

The USFS and Champion International agreed to defer any additional logging in the Twelve-Rock timber sale (Middle Fork Rock Creek zone) until after this study is completed. The Hawk-Packer timber sale (Packer Creek zone) was an active sale in 1984 that affected at least study transects #4-8. Data analysis and recommendations will be handled differently if necessary for those areas where line construction and the Hawk-Packer sale overlap. To mitigate the influences of this activity, road building and logging in both

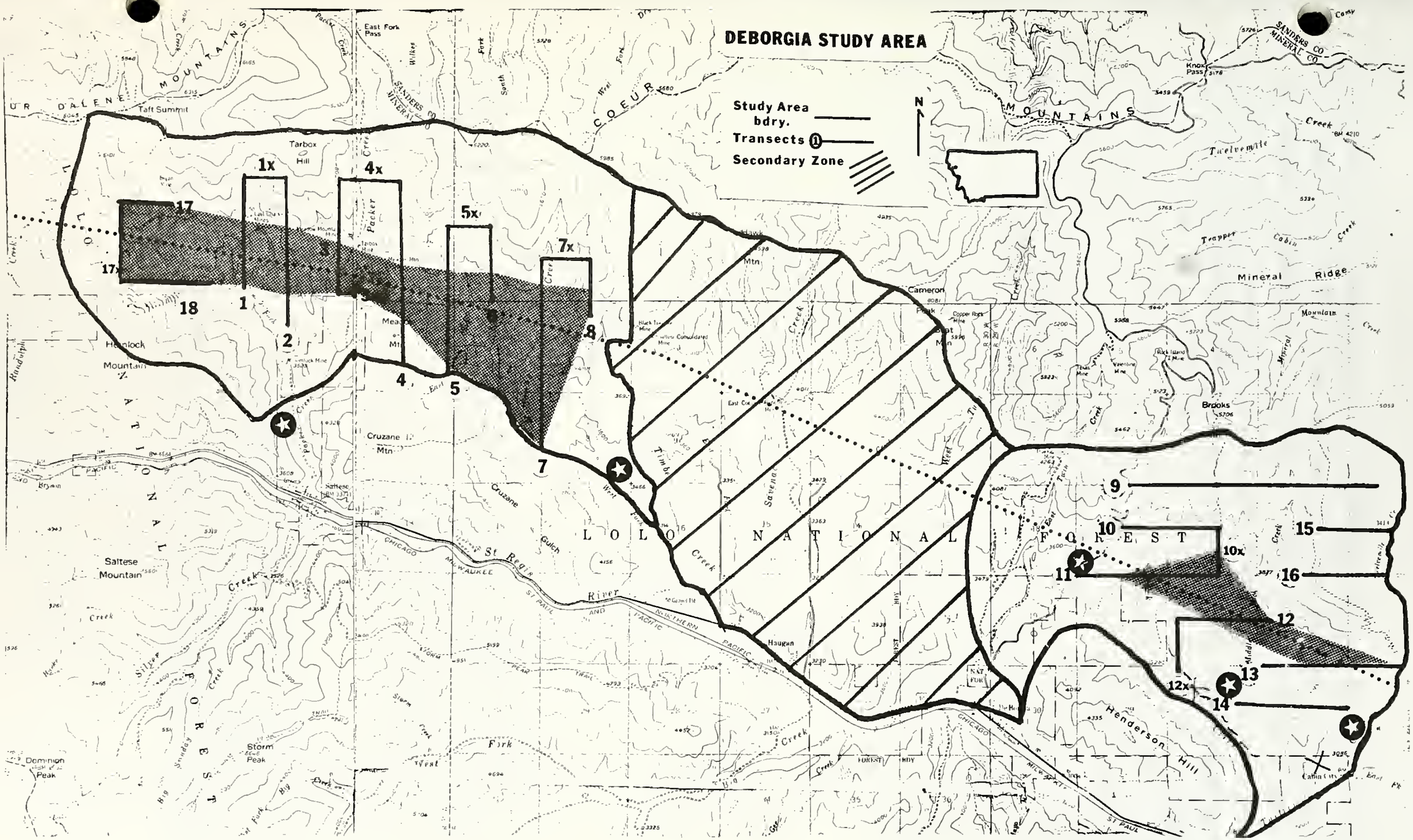


Fig. 4. Location of the DeBorgia study area, pellet transects, and traffic counters (stars) in relation to the BPA powerline (dotted line) near DeBorgia, Montana. The shaded areas are powerline-influenced analysis units used to evaluate elk distribution (see pp 14-15).

the Hemlock Mountain (Packer Creek zone) and the Twin-Savenac Creek (secondary study zone) areas were deferred for the duration of this study. In addition, three new study transects (#17, 17X, and 18) were established in 1984 on Hemlock Mountain, at the study area's west end, to mitigate the disturbance to the study associated with the Hawk-Packer sale. This sale was inactive in 1985 and 1986.

PROGRESS

1. Review Literature

An annotated bibliography of selected references was presented in the annual progress reports for 1984 and 1985 (Hammond et al. 1985, Thompson and Sterling 1986). This was not ammended substantially in this report period. All references that were consulted to collect and interpret data are listed in the "References Cited" section of this report.

2. Map Vegetation and Habitat Types

Existing maps of vegetation and other habitat features were used to analyze elk habitat selection. These included maps of landtypes and roads provided by the Lolo National Forest. No additional mapping of habitat features was performed this year.

3. Develop Analytical Procedures and Standard Data Forms

General procedures and forms were devised and described previously (Hammond et al. 1985) and were not ammended in this report period.

4. Elk Pellet-Group Transects

4.1. Methods: Elk fecal pellet-groups were counted along 41 belt transects (2 x 64,410 m combined length) established and described by Elliott (1983) to monitor elk distribution in relation to the powerline project on the 2 study areas (Figs. 3, 4). Pellet group counts were stratified by transect-segment and time period. Each transect was divided into segments wherever obvious changes in vegetation, aspect, or slope were detected; maximum segment length was arbitrarily set at 183 m (Elliott 1983). Each segment was marked for the study duration with colored spray paint and plastic flagging.

Counts were replicated 3 times in 1986 during the following time periods: 4-23 June, 13-22 August, and 30 September-8 October. Counts were replicated similarly in 1985 (Thompson and Sterling 1986), 1984 (Hammond et al. 1985), and September-October 1983 (Elliott 1983); the final replicate is scheduled for June 1987. Pellet groups were cleared from the transects during each replication; therefore, pellet-group counts begun on 30 September generally represented relative elk use in September, and counts begun on 13 August represented relative elk use in July-August. Pellet groups counted

during June replicates were classified according to relative age classes; "fresh" and "new" pellet groups were assumed to represent relative elk use in May-June, while "old" and "very old" pellet groups were assumed to represent relative elk use during the previous hunting season (October-November). It was assumed that elk were not present on the study areas during winter (generally December-April). Subsequent telemetry studies generally supported this assumption (Thompson and Sterling 1986), although limited winter use of the lower Timber Creek and Middle Rock Creek drainages in the DeBorgia study area was documented in January-March 1986 (Henderson and Lemke 1987).

A review of the pellet-group count technique is provided by Neff (1968). The potential problems of sampling design, observer bias, etc. discussed by Neff (1968) may be accounted for in this study by cautious interpretation of the data. The technique may be invalid, however, if used here as an indicator of habitat preferences. Neff (1968) concluded that the use of pellet-group distribution pattern as an index of habitat preferences was a major problem requiring further study. More recently, Collins and Urness (1979) found significant differences between elk pellet-group distributions and actual distributions of elk activity. They concluded that the pellet group method did not accurately represent relative habitat segment use. Marcum et al. (1984) declined to rely on 9 years of pellet-group distribution data to indicate elk habitat preferences in western Montana, and suggested that the technique may be valid only for coarse-grain habitat evaluations.

Two additional problems specific to this study were expected to invalidate pellet group distributions as useful indicators of habitat preferences. First, pellet groups were obviously less observable where the transects crossed dense vegetation (particularly in the DeBorgia study area) than where the transects crossed openings and less dense understories. This was considered to be a serious source of bias in evaluating relative elk use of dense cover patches and productive feeding sites. Secondly, telemetry studies indicated that the pellet-group transects sampled only a relatively small proportion of habitats available to study-area elk populations within their traditionally-used home ranges; further, substantial proportions of the populations selected habitats away from the transects during most of the year (Hammond et al. 1985, Thompson and Sterling 1986). Therefore, indications of habitat preferences from the pellet group data would be difficult to interpret reliably and may be misleading to managers responsible for the study area elk populations.

In view of these considerations, pellet group counts were used only to detect broad differences between observed and expected elk use of powerline-influenced areas. Powerline-influenced areas were defined as those areas located adjacent to the powerline corridor and associated new road system. Areas that met this definition typically were located within 1 km or less of the powerline (Figs. 3, 4). The width of this powerline-influenced belt was expanded as necessary to include switchbacks in the new road system, and was reduced where topographic relief and dense vegetation were expected to mitigate disturbances to elk (Marcum et al. 1984:167-169).

Transect-segments that sampled powerline-influenced areas were combined to form powerline-influenced analysis units (PIAU's) specific to each of the 4 study zones (Figs. 3, 4). The overall extent (elk-days) of elk use indicated by pellet group counts in the study zones was expected to vary both seasonally and annually for reasons that were not powerline-related. For example, observer biases in the pellet group counts (Neff 1968), differential defecation rates due to variable forage quality and quantity (Collins and Urness 1979), and differential elk habitat selection and

distribution due to variations in weather conditions (Marcum and Scott 1985) were likely in all study zones over the course of the study. It was assumed, however, that the proportions of study-zone elk use recorded within the PIAU's would be constant from year to year and independent of changes in overall levels of indicated elk use if elk distribution was not affected by the powerline project. This seemed reasonable since observer biases and the availability of elk habitat components appeared to be consistent within and without the PIAU's.

Chi-square analysis was used to test the following null hypotheses:

1. There is no difference between the proportions of elk use (percent of total pellet group count) recorded and the corresponding proportions of sampling effort (percent of total transect length) expended in the PIAU's.

2. There is no difference between the proportions of elk use recorded before powerline construction (1983) and those recorded during (1984-1985) or after (1986) construction in the PIAU's.

Tests were specific to study zone and season. Calculations were performed using the computer program STATGRAPHICS (STSC, Inc., Copyright 1986).

4.2. Results and Discussion: No significant difference ($P > 0.05$) was found between relative elk use (observed) and relative sampling effort (expected) in the PIAU's in 44 of 52 (84.6%) instances where pellet groups were counted on the transects of a particular study zone (Figs. 5, 6, 7, 8). This indicates that elk generally used powerline-influenced habitats in proportion to their availability before, during, and after construction of the powerline and associated new roads, despite wide seasonal and annual fluctuations in overall elk use as indicated by total pellet group counts (Figs. 9, 10, 11, 12).

Examination of the 8 instances in which relative elk use was significantly different than expected ($P < 0.05$) revealed that these exceptions were not automatically attributable to the powerline project. Three of these instances occurred before powerline and road construction (1983) in the Middle Fork Rock Creek and Harvey-Eightmile Uncut study zones (Figs. 6, 7). Two others in the Harvey-Eightmile Uncut zone indicated that relative elk use was significantly higher than expected in the PIAU, despite construction disturbances ongoing in 1984 (Fig. 7). These 5 instances of significant differences between observed and expected relative elk use indicated that some unknown determinant of elk distribution, independent of the powerline project, was disproportionately

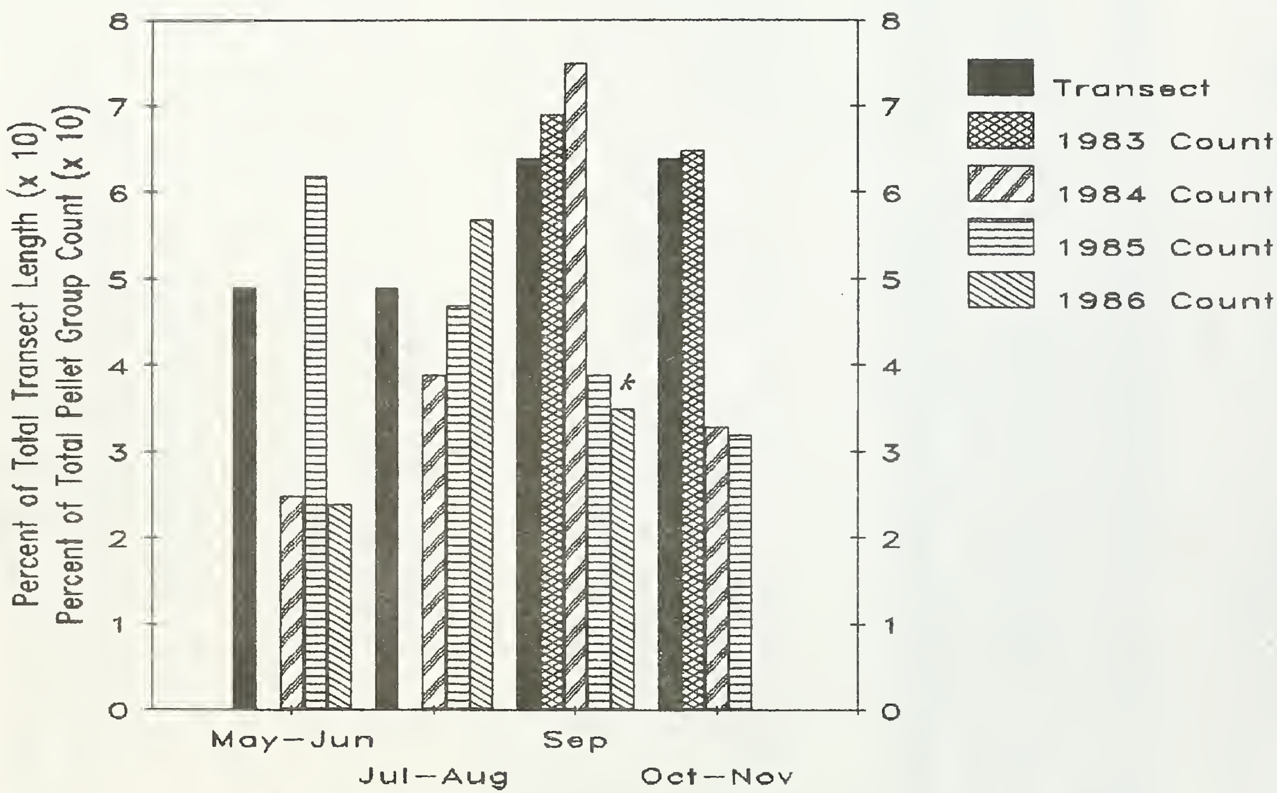


Fig. 5. Percent total transect length (relative sampling effort) and percent total pellet group count (relative elk use) in powerline-influenced portions of the Packer Creek study zone, near DeBorgia, Montana. Sampling effort varied among time periods, but was adjusted to remain constant for year-to-year comparisons within time periods. Asterisks depict significant differences ($P < 0.05$) between relative elk use and relative sampling effort. Stars depict significant differences ($P < 0.05$) between relative elk use before (1983) and after (1984-1986) initiation of powerline and road construction. No data was available for May-Jun and Jul-Aug 1983, and Oct-Nov 1986.

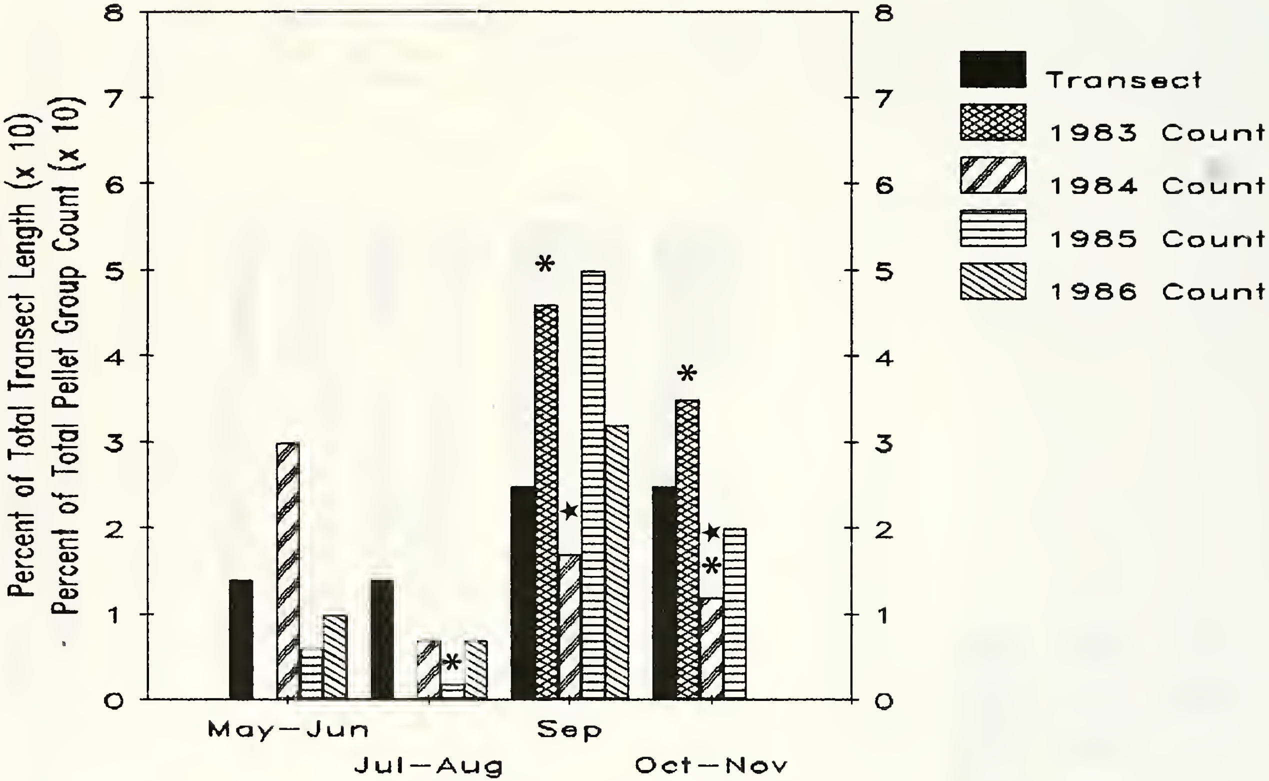


Fig. 6. Percent total transect length (relative sampling effort) and percent total pellet group count (relative elk use) in powerline-influenced portions of the Middle Fork Rock Creek study zone, near DeBorgia, Montana. Sampling effort varied among time periods, but was adjusted to remain constant for year-to-year comparisons within time periods. Asterisks depict significant differences ($P < 0.05$) between relative elk use and relative sampling effort. Stars depict significant differences ($P < 0.05$) between relative elk use before (1983) and after (1984-1986) initiation of powerline and road construction. No data was available for May-Jun and Jul-Aug 1983, and Oct-Nov 1986.

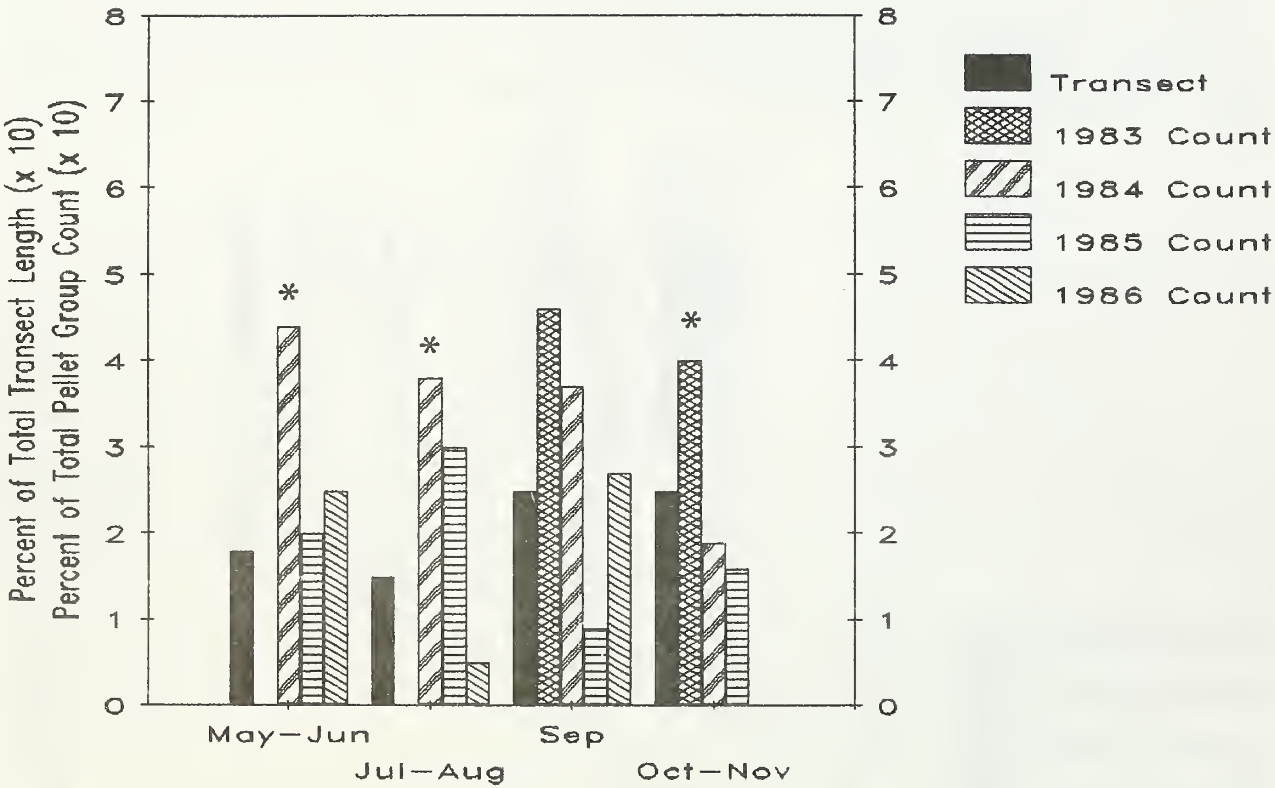


Fig. 7. Percent total transect length (relative sampling effort) and percent total pellet group count (relative elk use) in powerline-influenced portions of the Harvey-Eightmile Uncut study zone, near Hall, Montana. Sampling effort varied among time periods, but was adjusted to remain constant for year-to-year comparisons within time periods. Asterisks depict significant differences ($P < 0.05$) between relative elk use and relative sampling effort. Stars depict significant differences ($P < 0.05$) between relative elk use before (1983) and after (1984-1986) initiation of powerline and road construction. No data was available for May-Jun and Jul-Aug 1983, and Oct-Nov 1986.

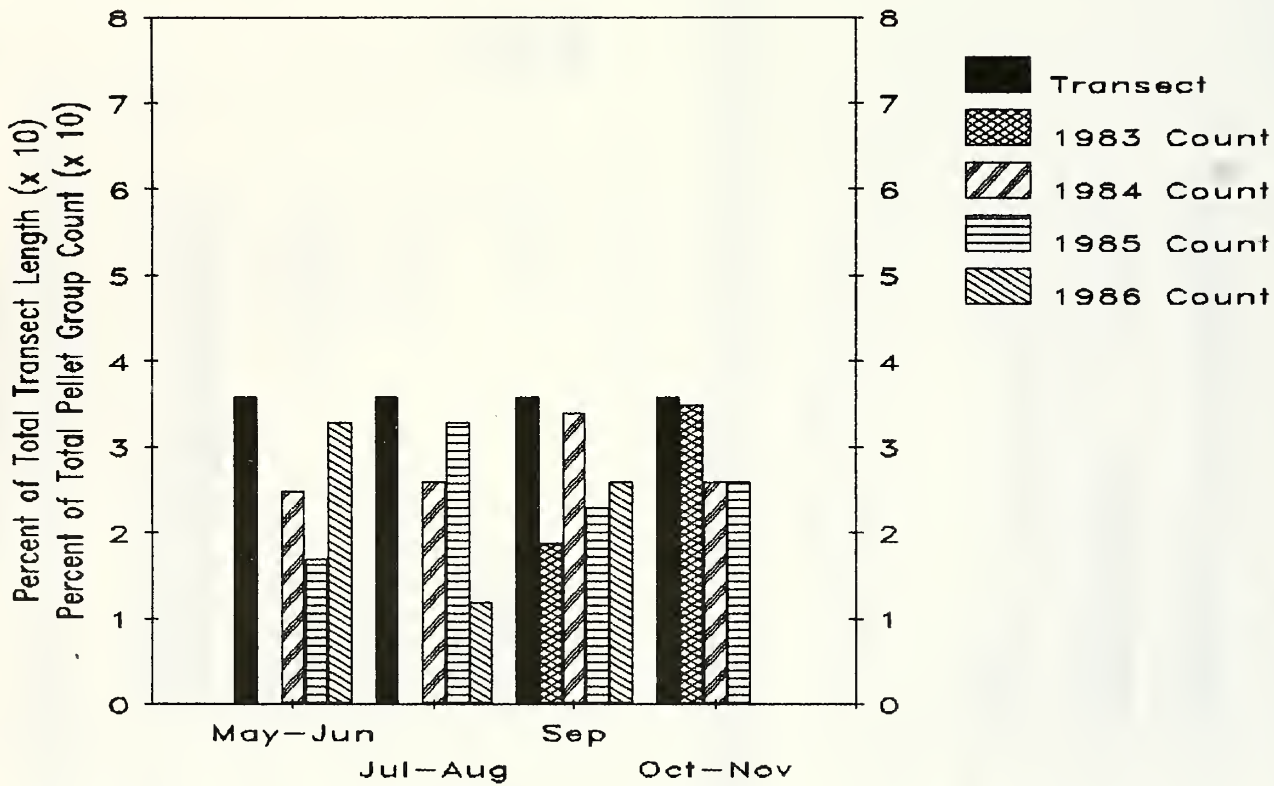


Fig. 8. Percent total transect length (relative sampling effort) and percent total pellet group count (relative elk use) in powerline-influenced portions of the Harvey-Eightmile Cut-over study zone, near Hall, Montana. Sampling effort varied among time periods, but was adjusted to remain constant for year-to-year comparisons within time periods. Asterisks depict significant differences ($P < 0.05$) between relative elk use and relative sampling effort. Stars depict significant differences ($P < 0.05$) between relative elk use before (1983) and after (1984-1986) initiation of powerline and road construction. No data was available for May-Jun and Jul-Aug 1983, and Oct-Nov 1986.

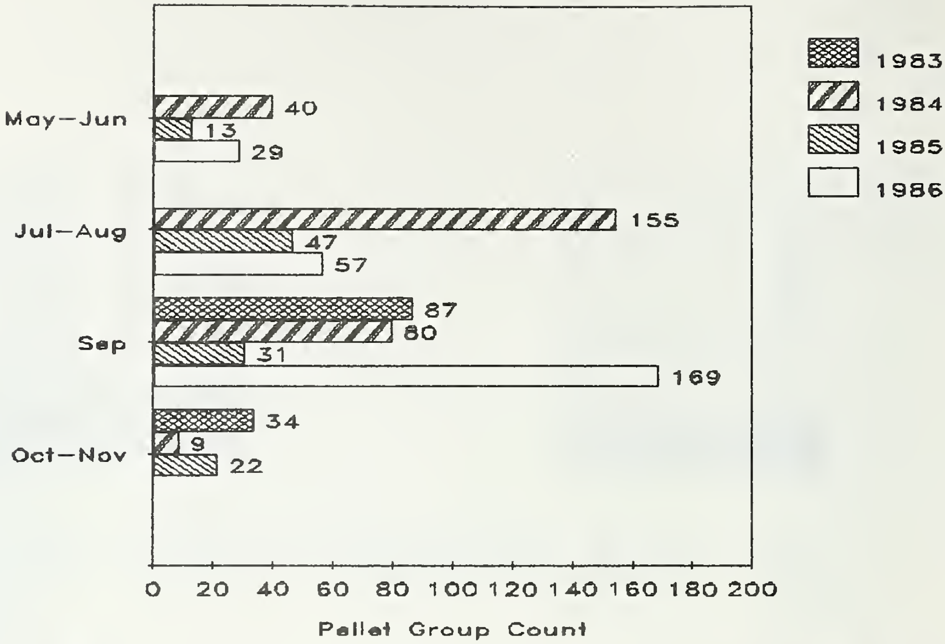


Fig. 9. Elk pellet group counts on transects in the Packer Creek study zone, near DeBorgia, Montana. Transect length varied among time periods, but was adjusted to remain constant for year-to-year comparisons within time periods.

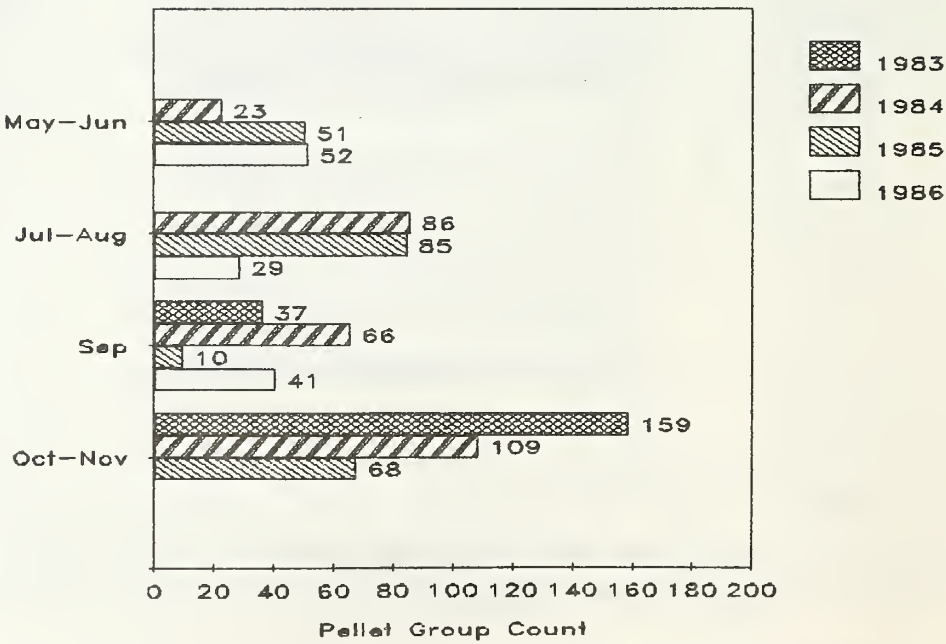


Fig. 10. Elk pellet group counts on transects in the Middle Fork Rock Creek study zone, near DeBorgia, Montana. Transect length varied among time periods, but was adjusted to remain constant for year-to-year comparisons within time periods.

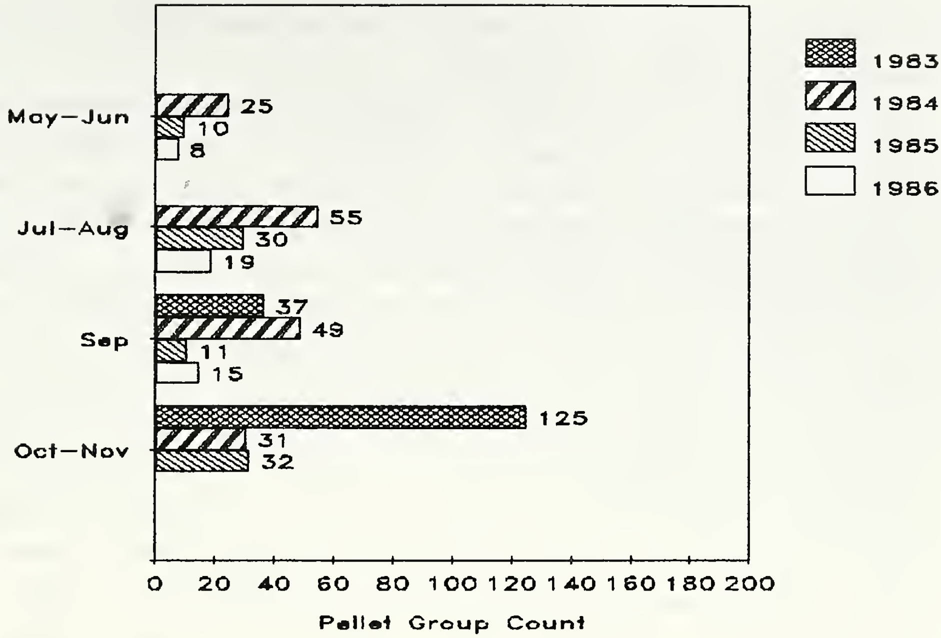


Fig. 11. Elk pellet group counts on transects in the Harvey-Eightmile Uncut study zone, near Hall, Montana. Transect length varied among time periods, but was adjusted to remain constant for year-to-year comparisons within time periods.

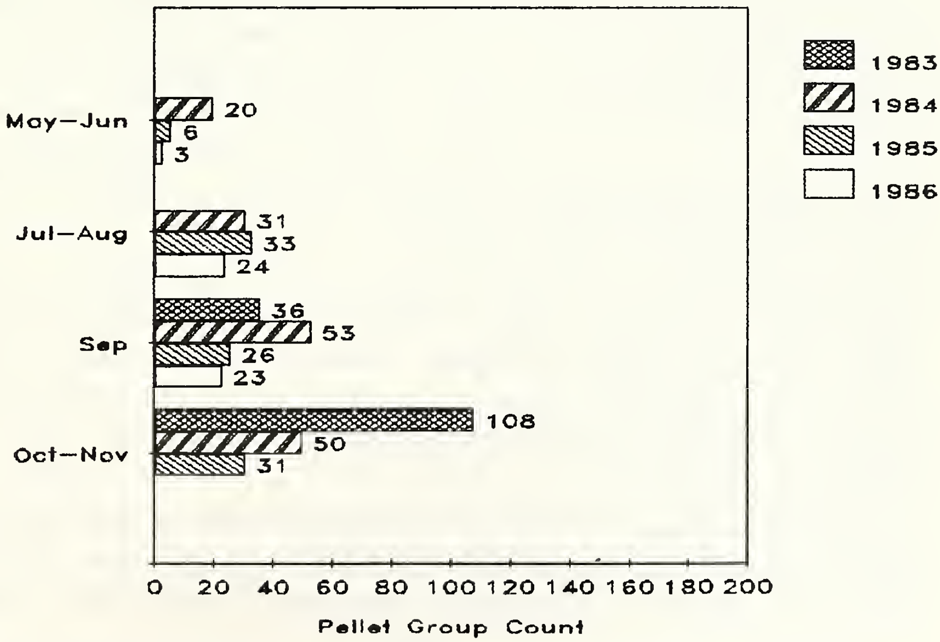


Fig. 12. Elk pellet group counts on transects in the Harvey-Eightmile Cut-over study zone, near Hall, Montana. Transect length varied among time periods, but was adjusted to remain constant for year-to-year comparisons within time periods.

available with respect to the PIAU's. This was observed in 2 of the 4 study zones and in 2 of the 4 study years.

The remaining 3 significant differences indicated instances where the relative elk use of PIAU's was lower than expected. Two of these occurred in the Middle Fork Rock Creek study zone (Fig. 6), where it was shown that differences in relative elk use may not be clearly attributable to the powerline project due to unknown annual and seasonal variation in determinants of elk distribution which were disproportionately available in the PIAU. For example, large annual variations in relative elk use of the Middle Fork Rock Creek PIAU may have been the result of a correlation between the attractiveness of a particular habitat component to elk and cumulative precipitation (Marcum and Scott 1985), rather than a reaction to the powerline project. Similarly, 1 instance where the relative elk use of the Packer Creek PIAU was significantly lower than expected (September 1986) followed another instance during construction activity when observed elk use clearly appeared as expected (Fig. 5, September 1984). Therefore, this analysis suggests that elk exhibited a negative distributional response to the powerline project during 2 time periods in the Middle Fork Rock Creek zone and 1 time period in the Packer Creek zone, but does not provide conclusive evidence.

The general lack of powerline-related impacts on elk distribution indicated here may be caused in part by 2 problems of study design and/or analysis. First, small sample sizes of total pellet groups counted on the transects (Figs. 9, 10, 11, 12) greatly reduced the sensitivity of the chi-square tests to the extent that the null hypothesis could be rejected only when observed and expected values differed extremely (Snedecor and Cochran 1967:20-29). This was apparent by visual comparison of widely divergent observed and expected values that were <u>not</u> significantly different (Figs. 5, 6, 7, 8). Second, the PIAU's may have been delineated too broadly to detect relatively subtle elk distributional responses. However, smaller, more restrictive PIAU's would decrease the range of variation of pellet counts that could be recorded in the PIAU's, which would further reduce the sensitivity of statistical analyses.

Visual comparisons of observed and expected relative elk use within the PIAU's suggested that negative distributional responses by elk to the powerline project were more likely during hunting season than any other time-

period studied (Figs. 5, 6, 7, 8). Observed relative elk use (represented by data from 1984-1985) in powerline-influenced habitats was always lower than expected (represented by data from 1983 and by relative transect lengths) during hunting season (October-November), although most of these differences were not statistically significant. No consistent relationship between observed and expected elk use of PIAU's was apparent during any other season.

Marcum et al. (1984:165-171) previously observed an enhanced avoidance response by elk when hunting pressure was superimposed upon construction and other human activities along roads. Most new powerline project roads were closed to public vehicular traffic (although open to construction-related traffic) during hunting season, but these closures were not expected to completely compensate for losses of elk security because improved access to elk habitat remained for hunters on foot, horseback, mountain bikes, motorcycles, snowmobiles, and 3- or 4-wheelers (Lonner and Cada 1982, Leege 1984:10, Marcum et al. 1984:165, Lyon et al. 1985:42). Data from October-November 1986 were not yet available to test if possible avoidance responses to hunting pressure along the new roads persisted 1 year after powerline construction was completed.

There was no inference from statistical analysis or visual examination of the data that elk were attracted to seral vegetation structures created by the powerline corridor (Bramble and Byrnes 1979). General observations of plant growth along the powerline corridor during the summer and fall of 1986 indicated that revegetation of the corridor had not progressed to the extent that an attractive forage source was created.

Some differences exist between the data presented here and the corresponding data presented previously (Thompson and Sterling 1986). This is due to the manner in which data was screened for comparison among years. Screening was necessary because pellet groups were not counted on all transects during all replicates in 1984 and 1985 due to early snows. Therefore, annual comparisons of pellet group counts were adjusted to include only the transect-segments that were completed every year within a given time period. Thus, the percent of total transect length in a PIAU was constant among years within a given time period, but varied among time periods within a given year (Figs. 5, 6, 7, 8). A more refined method was used to screen the data for comparison purposes here, compared with the previous analysis

(Thompson and Sterling 1986), and accounts for most of the discrepancies between the 2 data sets presented. In addition, a math error was found and corrected for the current analysis.

4.3. Preliminary Conclusions: The null hypothesis that elk distribution generally was unchanged as a result of the powerline project was not rejected on the basis of statistical analysis of pellet group distributions. This statistical analysis may not have been sensitive to relatively subtle elk responses (e.g., major distributional shifts by a small proportion of the elk herd, or shifts of the entire herd within a 1-3 km band encompassing the powerline corridor and road system) due, in part, to low total pellet group counts. Visual comparison of the data indicated that relative elk use of powerline-influenced areas was consistently (but generally not statistically) lower during hunting season than would be expected in the absence of the powerline project. Data for the 1986 hunting season (to be collected in June 1987) will provide an improved basis for drawing conclusions regarding possible post-construction avoidance of the powerline area by elk during the hunting season. A sufficient forage source had not yet developed in the powerline corridor in 1986 to serve as a noticable attractant to elk.

5. Summarize Elk Hunting Regulations and Harvest Data

5.1. Hunting Regulations: The DeBorgia and Harvey-Eightmile study areas are located within elk hunting districts (HD) 200 and 210, respectively (Fig. 2). Hunting regulations in these districts remained relatively constant from 1972-1986 as they pertained to the harvest of antlered bulls, but opportunities to harvest antlerless elk were reduced, beginning in 1976 (Figs. 13, 14), in response to accelerated harvest rates facilitated by increased road access (Firebaugh et al. 1980:18-19).

5.2. Harvest Model: Elk harvests varied greatly from year to year in both hunting districts during the 12 years immediately preceding powerline and road construction (Figs. 15, 16). An attempt was made to explain this variation

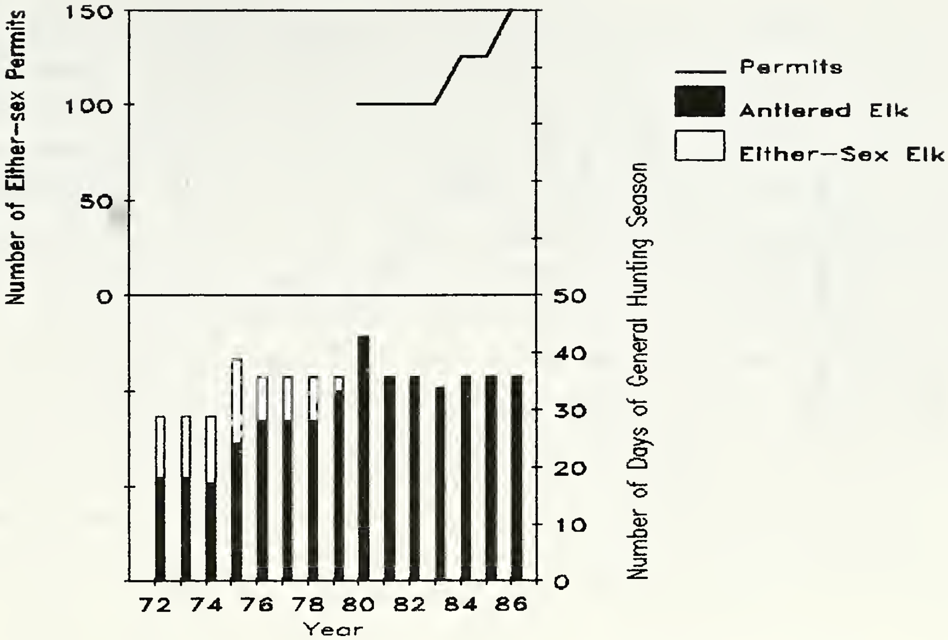


Fig. 13. Trends in elk hunting regulations from 1972-1986 in Montana elk hunting district 200, near DeBorgia.

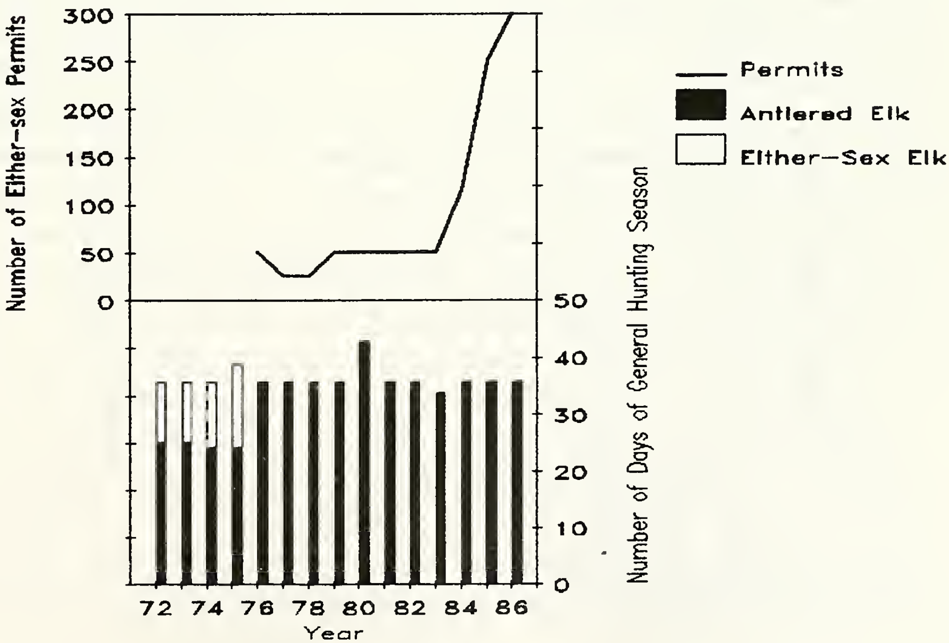


Fig. 14. Trends in elk hunting regulations from 1972-1986 in Montana elk hunting district 210, near Hall.

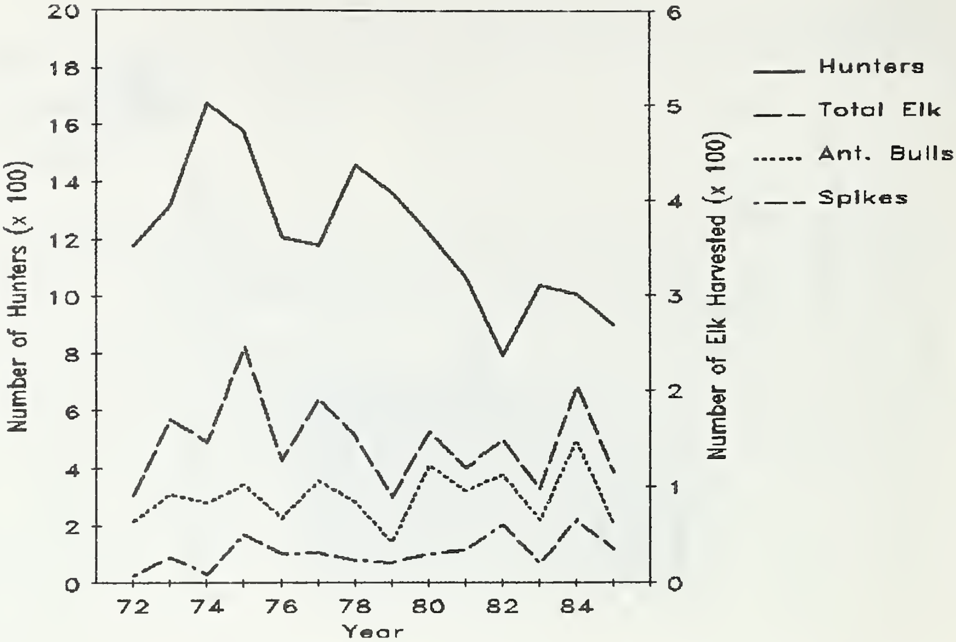


Fig. 15. Trends in hunting pressure and elk harvests from 1972-1985 in Montana elk hunting district 200, near DeBorgia.

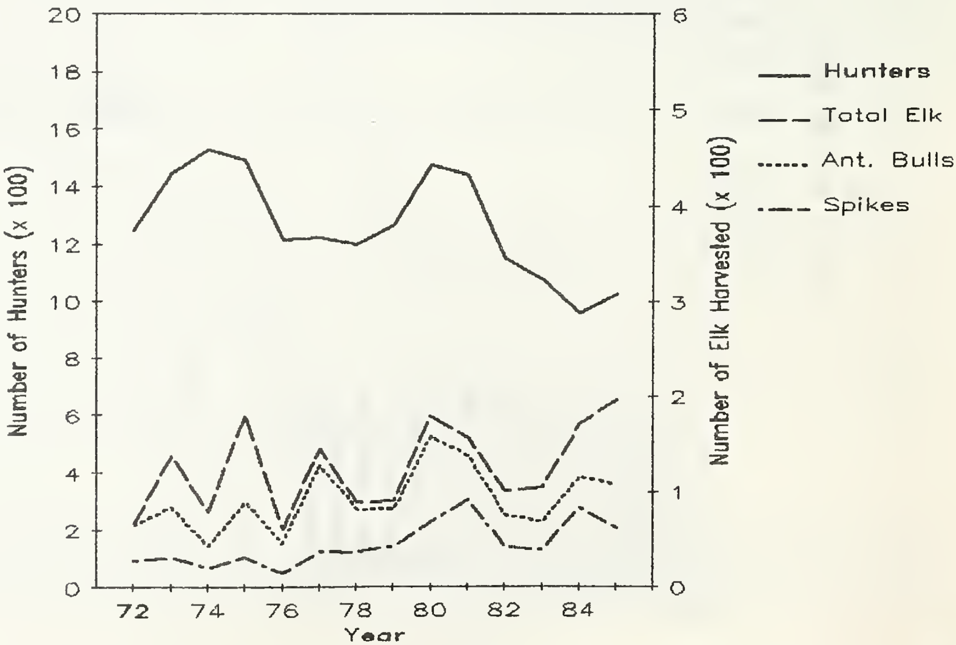


Fig. 16. Trends in hunting pressure and elk harvests from 1972-1985 in Montana elk hunting district 210, near Hall.

using multiple linear regression as a means of detecting impacts of the powerline project on elk harvests. A valid regression model, based on observations recorded before the powerline project was initiated, could be used to generate "control" harvest levels for comparison with actual harvest levels documented during and after powerline and road construction. The following analysis is a revision of the preliminary model and interpretations presented in the 1985 annual progress report (Thompson and Sterling 1986).

Data from all 6 hunting districts crossed by the Garrison-Taft powerline project were examined for the purpose of calculating harvest models. Sufficient data existed only for HD 210. Major changes in hunting regulations, a lack of critical elk population information, and major elk trapping/transplanting efforts in recent years were problems encountered when attempts were made to model elk harvests in the other 5 hunting districts.

Spike harvest (from annual DFWP statewide harvest surveys) was selected as the dependent variable in the harvest model for HD 210 because: (1) opportunities to harvest antlered males have been affected less by changes in hunting regulations since 1972 than opportunities to harvest antlerless elk, and (2) annual spike harvests were less variable and probably more easily explained than branch-antlered bull harvests (Fig. 16). The model considered the influences of 4 independent variables: hunter numbers (from annual DFWP statewide harvest surveys), elk population levels (from annual DFWP trend counts by airplane in April-May), October snowfall, and November snowfall (U.S. Dept. of Commerce weather data from Drummond airport).

Annual observations of the dependent and independent variables from 1978-1983 were used to derive the harvest model for HD 210. Only observations from 1976 forward were considered for the model because either-sex hunting by general license-holders was discontinued in 1976 (Fig. 14), shifting hunting pressure to bulls. Data from 1976 and 1977 were unusable because elk population trend counts were not accomplished in those years. Thompson and Sterling (1986) did not use 1981 data in the previous model because the ratio of calves per 100 cow elk was not recorded in the spring of 1981 and, therefore, was not available for use as an independent variable. We chose to use the 1981 data here because calf/cow ratios were not important in the previous model of spike harvests (Thompson and Sterling 1986), and the inclusion of the 1981 observations provided an improved range for the

variables in the model (Fig. 17). Hence, the model was derived from observations of the last 6 consecutive years before powerline and road construction began in 1984.

The regression of all 4 independent variables on spike harvests was not significant ($F = 10.24$, $P = 0.23$). Exclusion of the November snowfall variable, using the backward elimination procedure described by Draper and Smith (1966:167-169), resulted in a significant regression ($F = 27.28$, $P = 0.03$) incorporating the influences of October snowfall (partial $r = 0.95$, $P = 0.04$), hunter numbers (partial $r = 0.93$, $P = 0.06$), and elk population levels (partial $r = 0.61$, $P = 0.39$). The exclusion of November snowfall from the model caused a decrease in the regression coefficient (R^2) of only 0.0001, indicating that November snowfall was of no value as a predictor of spike harvests in HD 210 (Draper and Smith 1966:26). Variation in the 3 remaining parameters accounted for about 98% ($R^2 = 0.976$) of the annual variation in spike harvests. It was decided to terminate the backward elimination process at this point because elk population levels, hunter numbers, and October snowfalls differed before and after initiation of the powerline project in 1984 (Fig. 17); therefore it was necessary for the model to consider all of these potentially important variables.

Prior to using the regression model to generate "control" harvest levels for 1984 and 1985, the data were examined visually to determine if the values of the independent variables in these years were adequately represented by data in the model (Fig. 17). The second- and third-highest ranking values of October snowfall observed from 1978-1985 were in 1984 and 1985. Similarly, the 2 highest elk trend counts observed in this time period were in 1984 and 1985, and the 2 lowest hunter numbers were observed in 1984 and 1985. Thus, 2 of the 3 determinants of spike harvest varied beyond the "experience" of the model in the powerline project years of 1984 and 1985. Therefore, predictions of 1984 and 1985 spike harvests from the model were expected to be less reliable than predictions from within the range of variation accounted for in the model (Draper and Smith 1966:22).

An additional test of the reliability of the model as a predictive tool was conducted. Observations of the dependent and 3 independent variables from 1978-1982 were used to derive a model for estimating the 1983 spike harvest in HD 210. The model-generated and actual spike harvests for 1983 were expected

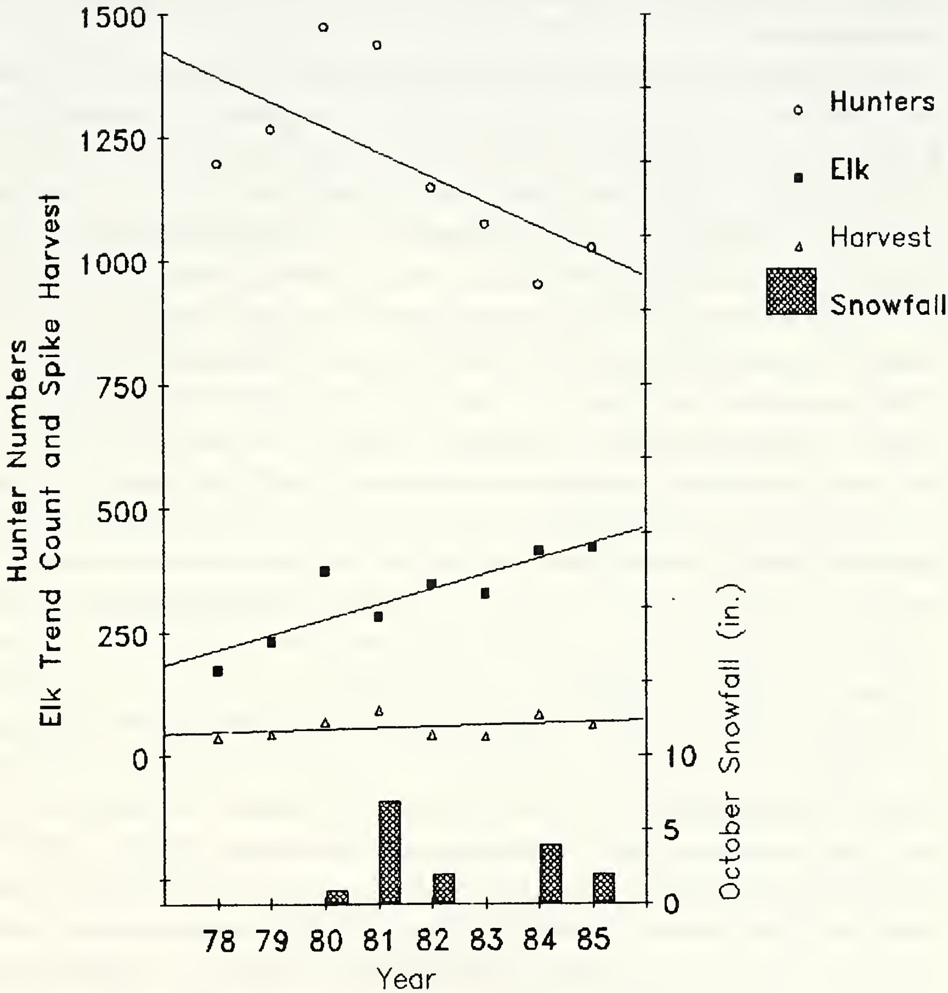


Fig. 17. October snowfall and trends in hunter numbers, elk numbers, and spike harvest from 1978-1985 in Montana elk hunting district 210, near Hall. The elk trend count for 1985 was incomplete, so counts from 1984 in specific locations that were not sampled in 1985 were used to supplement the 1985 count.

to be the same (within 1 standard error of the estimate) because all spike harvests from 1978-1983 occurred before initiation of the powerline project. However, the 1978-1982 model predicted a 1983 harvest of 28 (+ or - 0.0) spikes compared to the actual 1983 harvest of 39 spikes. Consequently, the model did not adequately account for the expected annual variation in spike harvests and cannot be relied upon to indicate powerline project impacts on spike harvests.

The significance of the regression and the very high regression coefficient (R^2) indicated no reason to doubt the predictive value of the model. However, Draper and Smith (1966:63,118) cautioned that artificially high regression coefficients may result when the number of variables in a model approaches the number of observations. In the case of the 1978-1983 model, there were 3 independent variables considered and only 6 observations. Further, $R^2 = 1.0$ in the 1978-1982 test model, which clearly indicated that the model actually reached the saturation point of variables relative to observations when the 1983 observation was removed (Draper and Smith 1966:63). Magnusson (1983) suggested that there should be about 10 observations on the dependent variable for every independent variable considered in a multiple regression analysis.

Examination of the data presented in Figure 17 suggested that spike harvests recorded during construction of the powerline and roads (1984 and 1985) generally were in line with variations in spike harvests observed since 1978. The spike harvest of 1984 was higher than average (83 compared to an average of 53 from 1978-1983), but coincided with a record high spike harvest throughout much of western Montana (MDFWP statewide harvest surveys, Region 2). Although elk are more vulnerable to harvest along roads than away from roads (Daneke 1980:51-52), there was no evidence from this analysis to suggest that the presence of new powerline project roads in 1984 and 1985 led to a substantial short-term increase in overall spike harvest. These observations apply to HD 200 as well as HD 210 (Figs. 15, 16). Further insights on harvest impacts of the powerline project may be provided by the results of the DNRC hunter opportunity study being conducted concurrently on both study areas (Allen 1984).

Although we were not successful in modeling the effects of hunting pressure, elk population levels, and weather on elk harvests, we believe that the method is promising (with larger sample sizes) as a means of quantifying

harvest impacts of human developments in elk habitat. Hansen et al. (1986) explained $\leq$ 56% of the annual variation in white-tailed deer harvests using multiple regression to assess the influences of hunting pressure, deer population levels, and weather; however, they did not evaluate the reliability of their regression as a predictive model. It may be worthwhile for managers to review the type and continuity of harvest-related information they gather, as well as the type and frequency of changes made in hunting regulations, if they desire to accumulate an adequate and versatile data base for assessing land use impacts on elk harvests.

5.3. Preliminary Conclusions: An attempt was made to quantify the effects of the powerline project on elk harvests using multiple regression analysis to model "control" harvest levels; however, a reliable predictive model could not be derived from the available data. Elk harvests for HD 200 and 210 did not appear out of line with recent harvest trends or region-wide harvests during powerline and road construction (1984 and 1985), although this study was not designed specifically to detect short-term impacts on elk harvests. The DNRC hunter opportunity study may provide more insights on the role of the powerline project as a potential facilitator of elk harvests when that study is completed in 1988 (Allen 1984).

6. Assist with DNRC Hunter Opportunity Survey

Phase II of the DNRC hunter opportunity study was conducted during the 1986 hunting season. Study proposals were reviewed, checking station signs were prepared, 2 traffic counter loops were replaced, 6 traffic counters were installed, 3 man-days were spent at the Harvey Creek checking station, and a DFWP 4x4 pickup was provided in cooperation with this effort.

7. Install and Monitor Traffic Counters

Traffic counters were installed immediately before the 1986 hunting season

at locations described by Allen (1984). Traffic counter data was collected during the hunting season by attendants at DNRC checking stations to provide data for the hunter opportunity study.

8. Capture and Collar Elk

8.1. Methods: Elk were captured using modified Clover traps (Clover 1954) baited with alfalfa (winter) or block salt (summer). Trapping in 1986 was conducted from January-March in HD 200 (Henderson and Lemke 1987), and from mid-June through August in HD 210. Elk were marked with a metal ear tag in each ear and were fitted with radio transmitters encapsulated in neck collars constructed of molded plastic pipe. The age of each elk was estimated by examining the condition of the upper canine teeth (Greer and Yeager 1967) and the replacement of the deciduous incisors.

8.2. HD 200 (DeBorgia): Trapping efforts were coordinated with the DFWP Lower Clark Fork Elk Project (LCFEP) to minimize the costs of both studies and eliminate duplication of effort (Henderson and Lemke 1987). The BPA-funded study contributed about 25% of the labor required for the cooperative trapping effort in HD 200. In addition, this study provided radio transmitters for $\leq$ 10 bull elk to provide improved data on elk security cover during the hunting season; this would complement the data on traditional movement patterns and habitat selection gathered from cow elk radioed by the LCFEP.

A total of 28 elk were radio-collared on the winter ranges of elk populations that might be affected by the powerline project (22 elk in HD 200 north of St. Regis and 6 elk south and west of Thompson Falls in adjacent HD 123; Fig. 2). Combined with the radioed elk available from trapping efforts in 1984 and 1985 (Thompson and Sterling 1986), a total of 35 cows and 9 bulls were monitored in the vicinity of the powerline project during 1986 (Fig. 18). General capture locations for elk trapped in 1984 and 1985 were presented in the 1985 progress report (Thompson and Sterling 1986:29); general capture locations for elk trapped in 1986 will be presented in the 1986 LCFEP report (Henderson and Lemke 1987). Ear tag numbers and other identification data for each radioed elk were listed in the DFWP Region 2 progress report for 1985-1986 (Firebaugh et al. 1986).

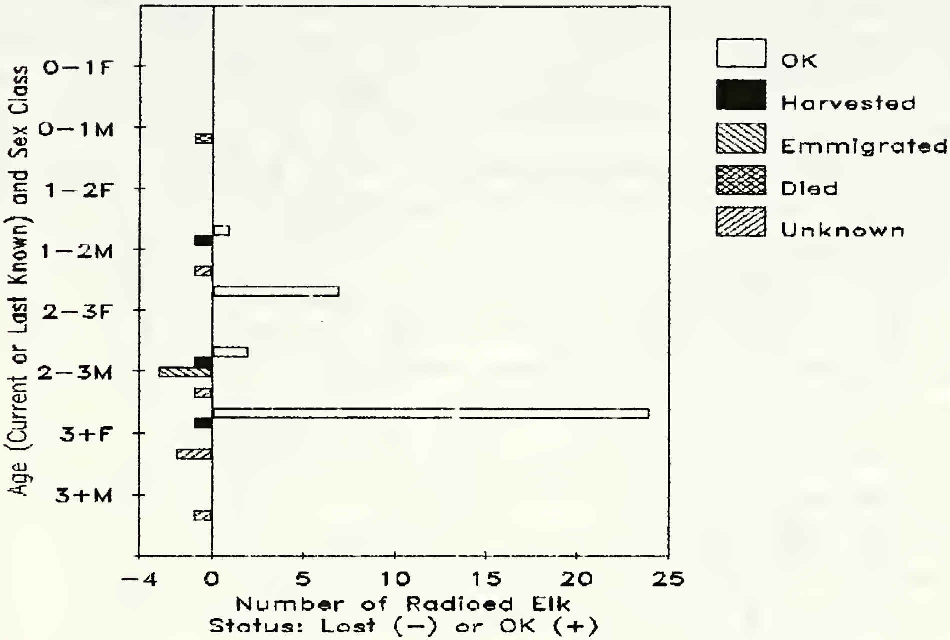


Fig. 18. Age and sex class and status (as known on 15 December 1986) of radioed elk captured from 1984-1986 that were relocated in the vicinity of the Garrison-Taft powerline project near DeBorgia, Montana.

8.3. HD 210 (Harvey-Eightmile): Elk that used the Harvey-Eightmile study area during summer and fall were not specifically sampled by telemetry studies in 1984 and 1985 (Thompson and Sterling 1986:33). An attempt was made to capture 10 elk that used the Harvey-Eightmile area as summer range in 1986 while supplementing the remaining sample of 1 radioed elk (from the original sample of 8 elk radioed in 1984) in HD 210. The number of traps set during 42 nights ranged from 3-10 (mode = 7), for a total of 266 trap-nights of effort. Three elk (2 yearling cows and a 2-year-old bull) were captured and radioed from 22-26 June, but only 1 elk (a 2-year-old bull that died in the trap) was captured thereafter. All 3 successful captures were made in the Brewster and Tyler Creek drainages (located on and near the western 1/2 of the study area), where 7 traps were monitored frequently from mid-June through early-August; additional effort was expended along the powerline southeast of the study area in August, but without success (Fig. 19). Identification data for the 4 radioed elk monitored in HD 210 in 1986 was listed by Firebaugh et al. (1986); the age- and sex-classes and status of radioed elk from 1984-1986 in HD 210 is presented in Fig. 20.

The relative lack of success of this summer trapping effort contrasts markedly with the results of a similar trapping effort in the DeBorgia study area in the summer of 1985 (Thompson and Sterling 1986). One factor that contributed to the relative success of the latter effort was the presence of 2 salted trap sites established previously in the summer of 1984 (Fig. 21). However, more elk also were captured on newly-established trap sites (with far less trapping effort) in the DeBorgia area than in the Harvey-Eightmile area. Further, 7 newly-established trap sites in the Harvey-Eightmile area were pre-baited with salt blocks as soon as the winter snowpack melted (1 month before the traps were set) to aquaint migrating elk with the presence of these salting grounds during the peak period of salt-hunger (Dalke et al. 1965). The probability of elk encountering the trap sites was enhanced by deploying as many traps as available (generally twice as many in 1986 as in 1985) along likely travel corridors (Fig. 19). Therefore, it is unlikely that a lack of established salting grounds was entirely responsible for the relatively poor trapping success in the Harvey-Eightmile area.

Instead, we believe that the poor 1986 trapping success indicated that relatively few elk used the western 1/2 of the Harvey-Eightmile study area in

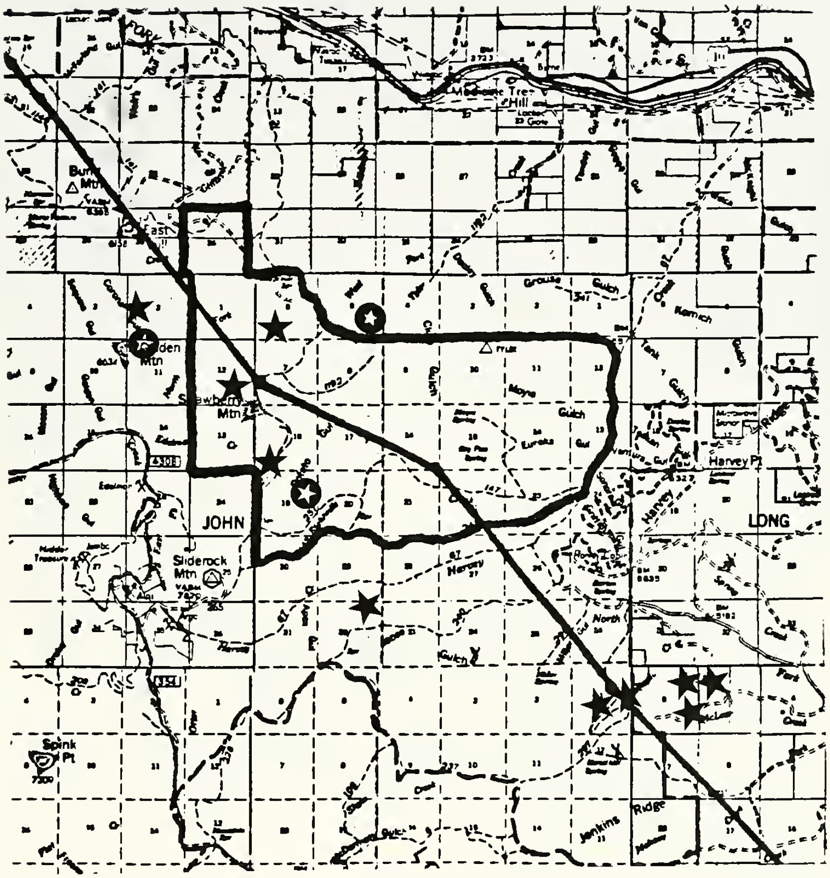


Fig. 19. Elk capture locations (white stars) and unsuccessful trap sites (black stars) near the Harvey-Eightmile study area (outlined) from June–August 1986. The location of the Garrison-Taft powerline is depicted by the solid diagonal line.

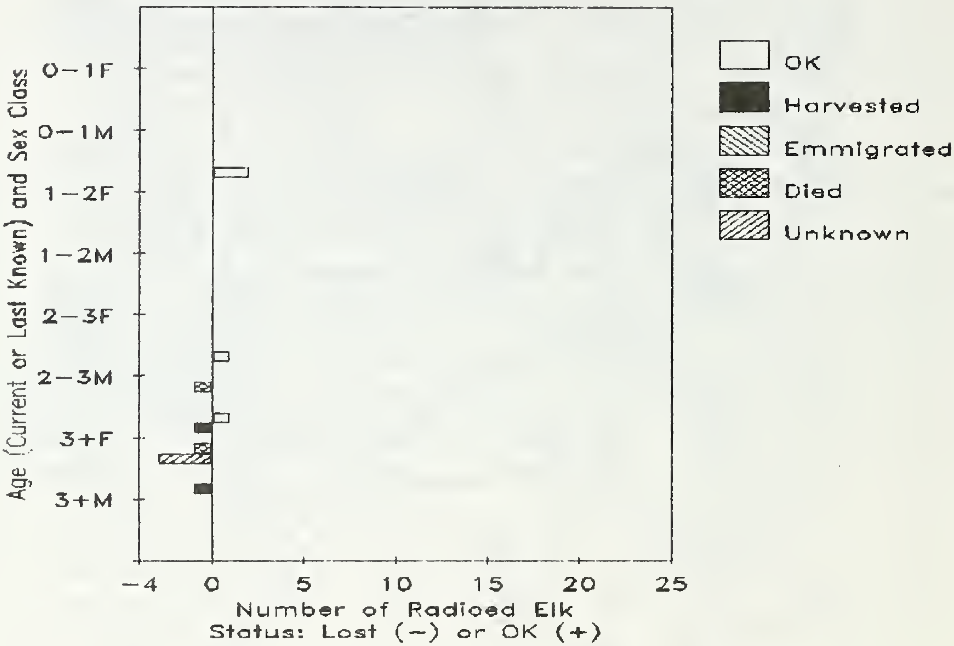


Fig. 20. Age and sex class and status (as known on 15 December 1986) of radioed elk captured in 1984 and 1986 that were relocated in the vicinity of the Garrison-Taft powerline project near Hall, Montana.

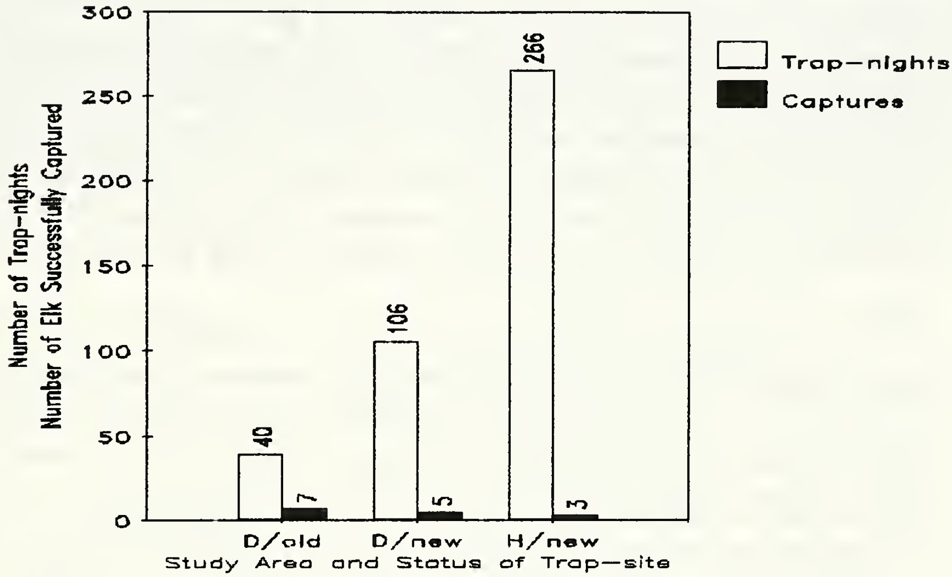


Fig. 21. Elk trapping effort and successful captures during summer on 1-yr-old, previously-salted trap sites near the DeBorgia study area (D) in 1985 compared with effort and captures on new trap sites established near the Deborgia area in 1985 and near the Harvey-Eightmile study area (H) in 1986.

the summer. It appeared that elk were captured as they migrated through the area immediately following the peak of calving season, but relatively few elk remained to frequent the trap sites thereafter. Known concentrations of elk existed southeast of the study area where traps were moved in late-July, but the attraction of elk to salt probably was reduced by that time (Dalke et al. 1965).

Although the trapping effort was relatively unsuccessful in substantially increasing the sample of radioed elk in HD 210, useful information was gained regarding the relatively low importance of the upper Brewster and Tyler Creek drainages as elk summer range in 1986. These results must be interpreted cautiously, however. The value of this summer range may vary from year to year as weather conditions vary (Marcum and Scott 1985), although elk pellet group counts from 1984-1986 in the Harvey-Eightmile Cut-over study zone did not reflect much annual variation in summer elk use (Fig. 12). Further, indications of relative elk use from these data may not be applied to any season other than the summer.

Two elk mortalities have occurred in 23 instances in which elk were captured and handled during summer trapping operations from 1984-1986. One mortality of a cow elk captured in HD 200 on 2 June 1985 was attributed to capture stress and complications associated with pregnancy (Thompson and Sterling 1986). The second mortality involved a 2-year-old bull captured on 25 July 1986 at the head of Tyler Creek (HD 210). This mortality apparently resulted from capture stress which, in turn, resulted from difficulties in positioning the elk properly in the trap due to the presence of antlers, the large size of the animal, and trap malfunctions. Both types of mortalities may be avoided in the future (i.e., trapping was not initiated until after the peak of calving season in 1986 and trapping crews can choose to release elk sooner if they cannot be handled easily in a trap); therefore, the past mortality rate was higher than the anticipated future risk of elk mortality during similar summer trapping operations.

9. Relocate Radioed Elk and Map Elk Security Areas

9.1. Methods: Radioed elk were relocated using a Piper Super Cub aircraft equipped with a belly-mounted, pivoting Yagi antenna. Relocations were plotted in the aircraft on 15-minute U.S. Geographic Survey topographic maps and were recorded in the office by UTM (Universal Transverse Mercator) coordinates to the nearest 100 m interval. Radio frequency, date, time of day, weather conditions, elevation, and general location were recorded for each relocation. Records from each flight were filed as memoranda to the DFWP Region 2 Wildlife Manager in a format suitable for computer entry, and copies were sent to DFWP and Forest Service biologists having a direct, cooperative interest in the raw data.

Relocation flights were accomplished from July-December in HD 210, and throughout 1986 in HD 200 (in cooperation with the LCFEP), with varying frequencies according to season (Fig. 22). Seasons were designated as follows: winter (January-March), spring (1 April-20 May), calving (21 May-25 June), summer (26 June-31 August), rut (1 September-8 October), pre-hunting (9-25 October), early-hunting (26 October-5 November), and late hunting (6 November-2 December). Relocation frequency was highest in the pre-hunting and early-hunting seasons in an attempt to evaluate elk security in preferred habitats. Relatively intensive relocation effort also was expended during calving season in HD 200 to provide information for land managers (Fig. 22).

The relative security of elk habitats was evaluated by comparing the observed movement patterns of radioed elk during a 12-day period immediately preceding the opening of the general elk hunting season (26 October 1986) with movement patterns observed during a 9-day period immediately following opening day. A daily relocation was recorded for each of 28 elk on 9 of 12 days before and 3 of 9 days after opening day in HD 200. Similarly, relocations were recorded for 4 elk on 5 days before and 3 days after opening day in HD 210. Weather conditions were similar throughout the time period—mild temperatures, no snowfall. Minimum home range polygons were plotted for each elk, using only the relocations recorded before hunting season, and compared with polygons drawn for each elk from relocations recorded during hunting season. In addition, the distances between successive relocations were measured on maps.

A trial analysis of the determinants of elk distribution was conducted using multiple linear regression in the manner described by Shannon et al. (1975). A 190 km^2 portion of HD 200, including the Middle Fork Rock Creek study zone (Fig. 23), was selected as the trial analysis unit because of the relatively high number of elk relocations recorded in that area. This analysis unit followed the boundaries of the summer-fall range for the majority of cow elk that wintered in HD 200 north of St. Regis (Henderson and Lemke 1987).

The analysis unit was subdivided into equal cells (1 x 1 km) along UTM coordinates. Measurements of relative elk use and environmental variables were tallied for each individual cell, providing 190 observations of these variables for analysis. The number of elk relocations per cell for pre-hunting seasons 1985 and 1986 combined was used as the dependent variable in the regression (a total of 137 relocations). Habitat variables were the area of each different landtype and the combined length of all landtype boundaries per cell. Landtypes were previously mapped by Lolo National Forest personnel, and each landtype represented a distinct combination of landforms, soils, and potential vegetation. The length of landtype boundaries was measured as an

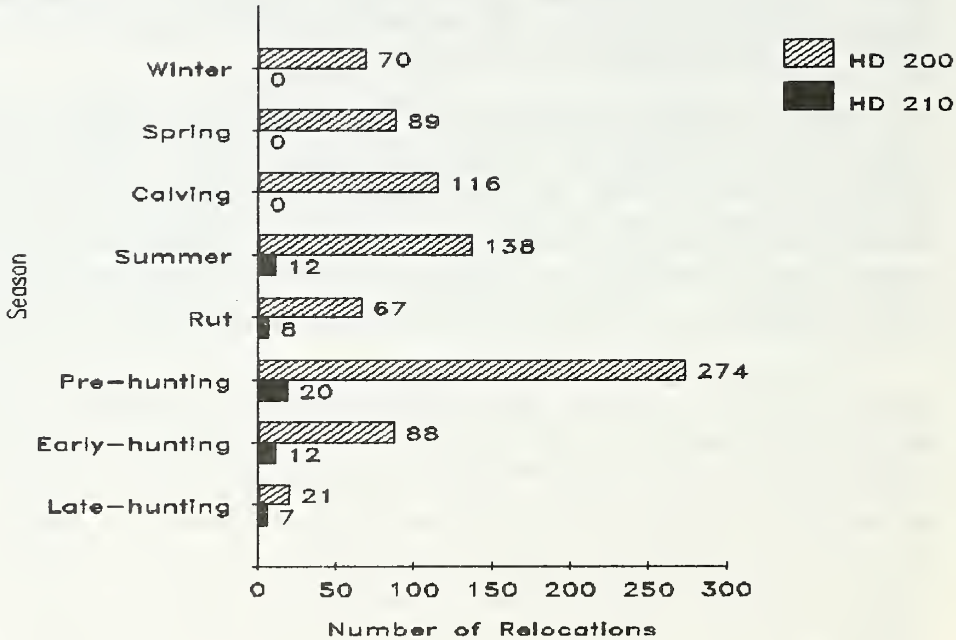


Fig. 22. Numbers of relocations of radioed elk recorded during 8 time periods in Montana elk hunting districts (HD) 200 and 210 in 1986.

Fig. 23. Location of a 190 km^2 trial analysis unit (shaded area) in Montana elk hunting district 200 near DeBorgia. The western half of the analysis unit includes the Middle Fork Rock Creek study zone.

indicator of habitat diversity within each cell (i.e., boundary lengths were expected to increase as diversity increased). Human activity variables were the lengths of: the powerline corridor, the new powerline access roads, the open roads, the roads closed to vehicles yearlong, and the trails per cell. Measurements of additional important variables, most notably current vegetation structure, were not as readily available, so they were not included in this trial analysis. Measurement of the variables was accomplished using maps and an electronic planimeter provided by the Lolo National Forest.

The stepwise regression procedure (Draper and Smith 1966:171-172) was used to arrive at a regression model that incorporated only the most influential variables affecting elk distribution. The regression coefficient (R^2) was calculated as an estimate of the amount of variation in relative elk use that was explained by the regression (Draper and Smith 1966:26). No attempt was made to present a predictive model based on this trial analysis; therefore, the slopes and intercept of the regression equation are not presented here. Computer program STATGRAPHICS (STSC, Inc., copyright 1986) was used to perform the calculations.

9.2. Seasonal Ranges: The seasonal ranges and movement patterns of radioed elk in HD 200 and adjacent HD 123 in 1986 will be presented by Henderson and Lemke (1987). General movement patterns in HD 200 during 1986 resembled those described previously (Thompson and Sterling 1986). Briefly, elk found in the vicinity of the powerline corridor during summer and fall have been relocated on winter ranges along Prospect Creek and Dry Creek in HD 123, and in the Tamarack Creek and Mullan Gulch drainages in HD 200. Prospect Creek elk tended to spend the summer and fall months near the western end of the powerline project in the Randolph Creek drainage. Dry Creek elk have been relocated in the powerline vicinity, but further to the east, generally between Packer and Twelvemile Creeks in the summer and fall. Tamarack Creek and Mullan Gulch elk generally were concentrated further east in the powerline vicinity in summer and fall; Rock Creek, Twelvemile Creek, and Flat Rock Creek were the most frequently-used drainages.

The single radioed elk in HD 210 that was captured in 1984 remained within previously-documented (Hammond et al. 1985, Thompson and Sterling 1986) seasonal ranges in 1986 (Appendix A). However, the 3 radioed elk captured in 1986 frequently were relocated well-outside of previously-documented seasonal ranges (Appendix A). Summer-fall elk habitats in the Tyler, Eightmile, and Harvey Creek drainages, within and without the Harvey-Eightmile study area, were identified for the first time in this study by monitoring these radioed

elk. Winter ranges for all 4 radioed elk were in the lower Rock Creek drainage, as documented previously for other radioed elk in HD 210 (Hammond et al. 1985, Thompson and Sterling 1986).

9.3. Elk Habitat Security (HD 200): Security is a feature of elk habitat that may be provided by some combination of vegetation, topography and distance from predators or human activity (Skovlin 1982:384-387). The ultimate consequences of inadequate habitat security may be suboptimal elk energy budgets (Morgantini and Hudson 1979, Skovlin 1982:386), or mortality due to hunting (Irwin and Peek 1979:203, Lonner and Cada 1982). Many researchers have assumed that the relative security, or effectiveness, of elk habitat is indicated by elk distributional responses to disturbance (Perry and Overly 1977, Irwin and Peek 1979, Morgantini and Hudson 1979, Lyon 1983, Lyon et al. 1985). Therefore, we adopted Lyon's (1986 unpubl.) definition of security as the "protection inherent in any situation that allows elk to remain in a defined area despite the increased stress of the hunting season". Habitat components that affect security levels are being investigated further by the Lolo National Forest (Canfield 1987), using data from this study and the LCFEP.

Forty-three percent (12 of 28) of the radioed elk demonstrated a marked change in daily movement patterns which corresponded with the opening of the general elk hunting season. This 43% was comprised of individual elk that met $\geq$ 1 of 2 criteria. The first criterion was that the distances between successive relocations were markedly different in pre-hunting season compared with early-hunting season. The second criterion was that the home range polygons of pre-hunting and early-hunting seasons were completely disjunct. Seven cow elk met criterion 1 (Fig. 24); the remaining 16 cows (Fig. 25) and 5 bulls (Fig. 26) did not. In addition, 9 elk (7 cows and 2 bulls) met criterion 2 (Fig. 27); 4 of these elk also met criterion 1, while the remaining 5 elk (3 cows and 2 bulls) were added to the tally of individual elk that appeared to react to hunting season (12 of 28 elk monitored). The pre-hunting and early-hunting season polygons of 19 elk overlapped and were not included in the tally of elk that appeared to react to hunting season on the basis of criterion 2 (Figs. 28, 29). Marcum et al. (1984:138-142) also

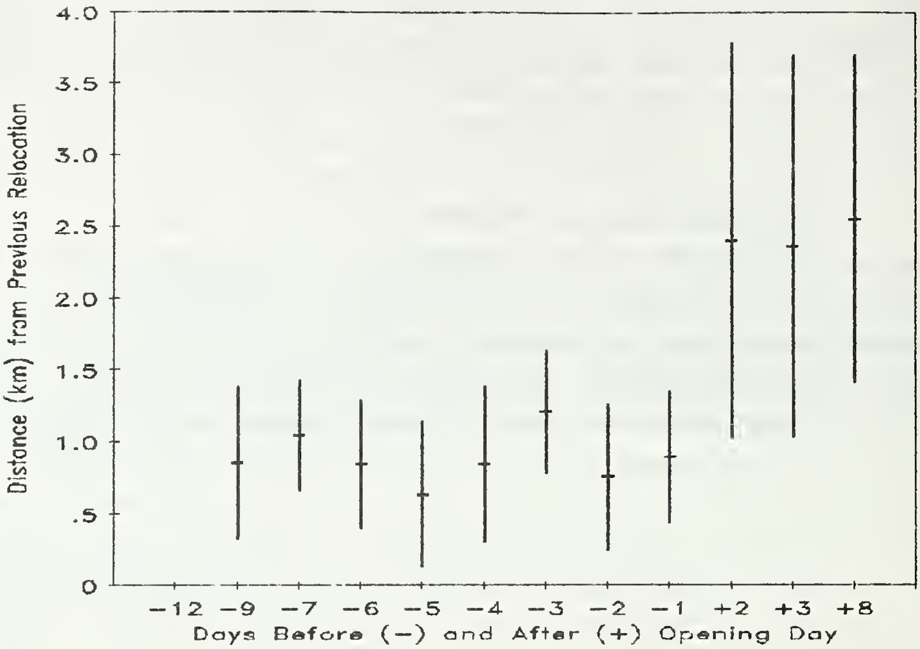


Fig. 24. Mean distances (and standard deviations) between successive relocations of 7 radioed cow elk immediately before and after the opening of the general elk hunting season (26 October) in Montana hunting district 200 in 1986.

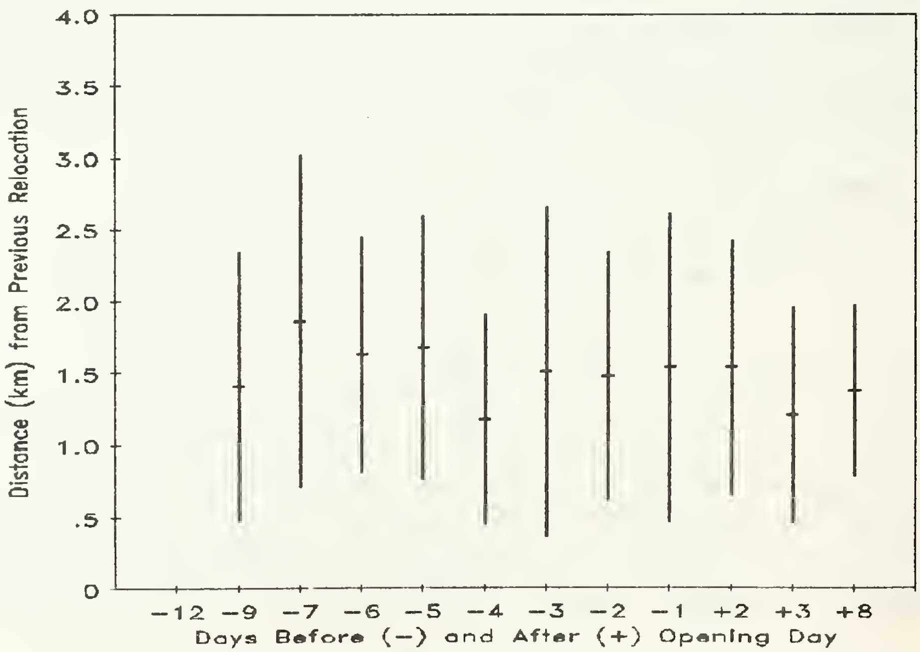


Fig. 25. Mean distances (and standard deviations) between successive relocations of 16 radioed cow elk immediately before and after the opening of the general elk hunting season (26 October) in Montana hunting district 200 in 1986.

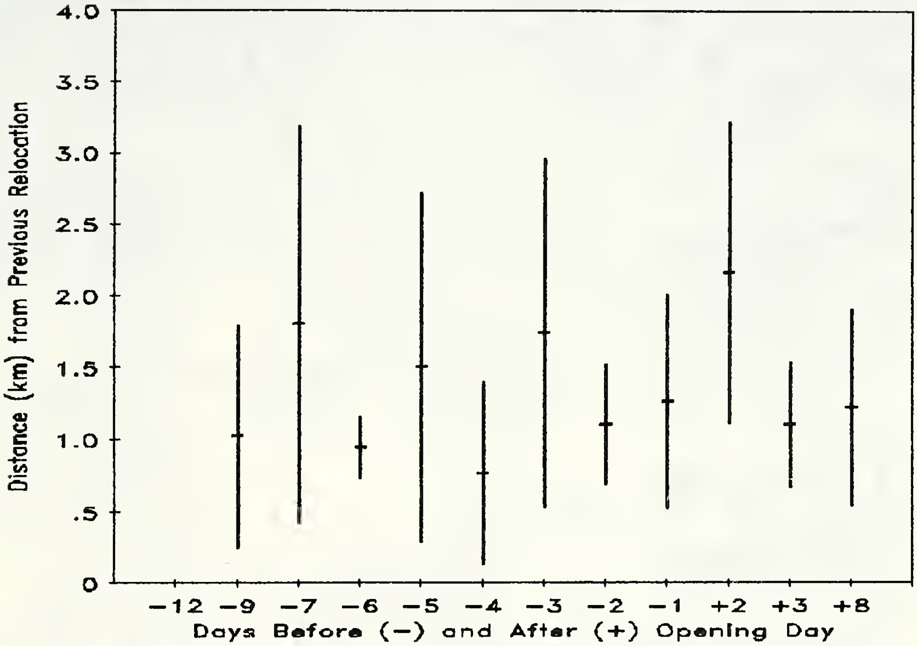


Fig. 26. Mean distances (and standard deviations) between successive relocations of 5 radioed bull elk immediately before and after the opening of the general elk hunting season (26 October) in Montana hunting district 200 in 1986.

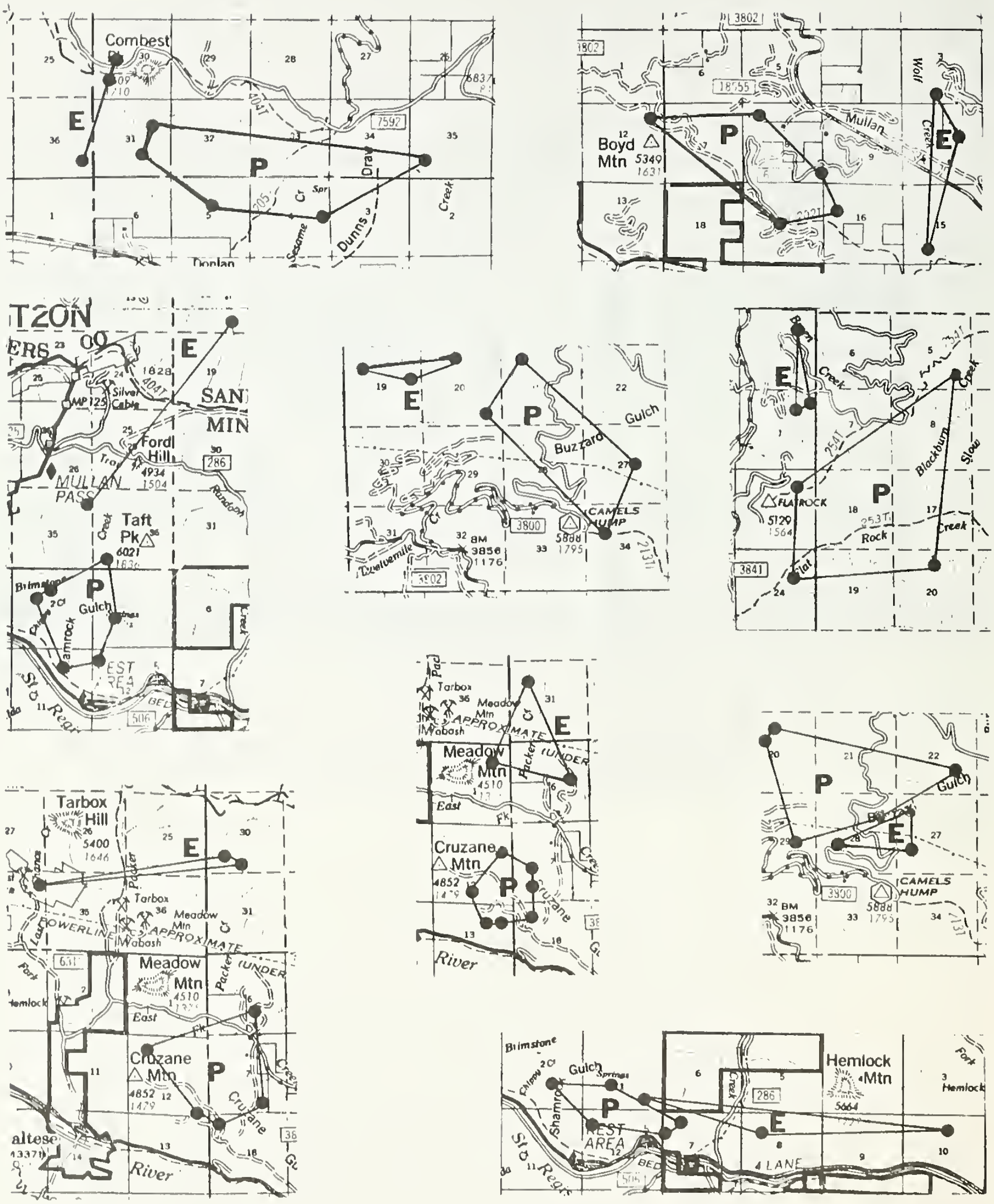


Fig. 27. Comparisons of the pre-hunting (P) and early-hunting (E) season home range polygons of 9 individual radioed elk relocated 12 times from 14 October-3 November 1986 in Montana elk hunting district 200, near DeBorgia.

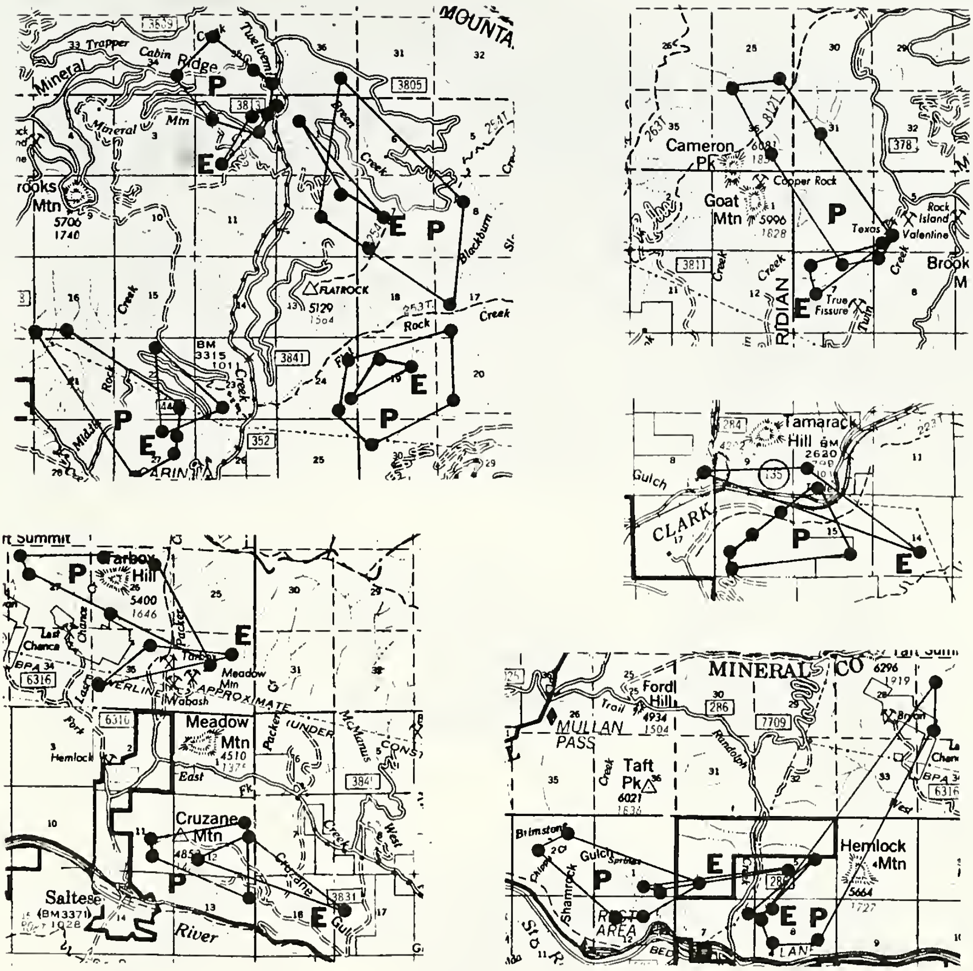


Fig. 28. Comparisons of the pre-hunting (P) and early-hunting (E) season home range polygons of 10 individual radioed elk relocated 12 times from 14 October-3 November 1986 in Montana elk hunting district 200, near DeBorgia.

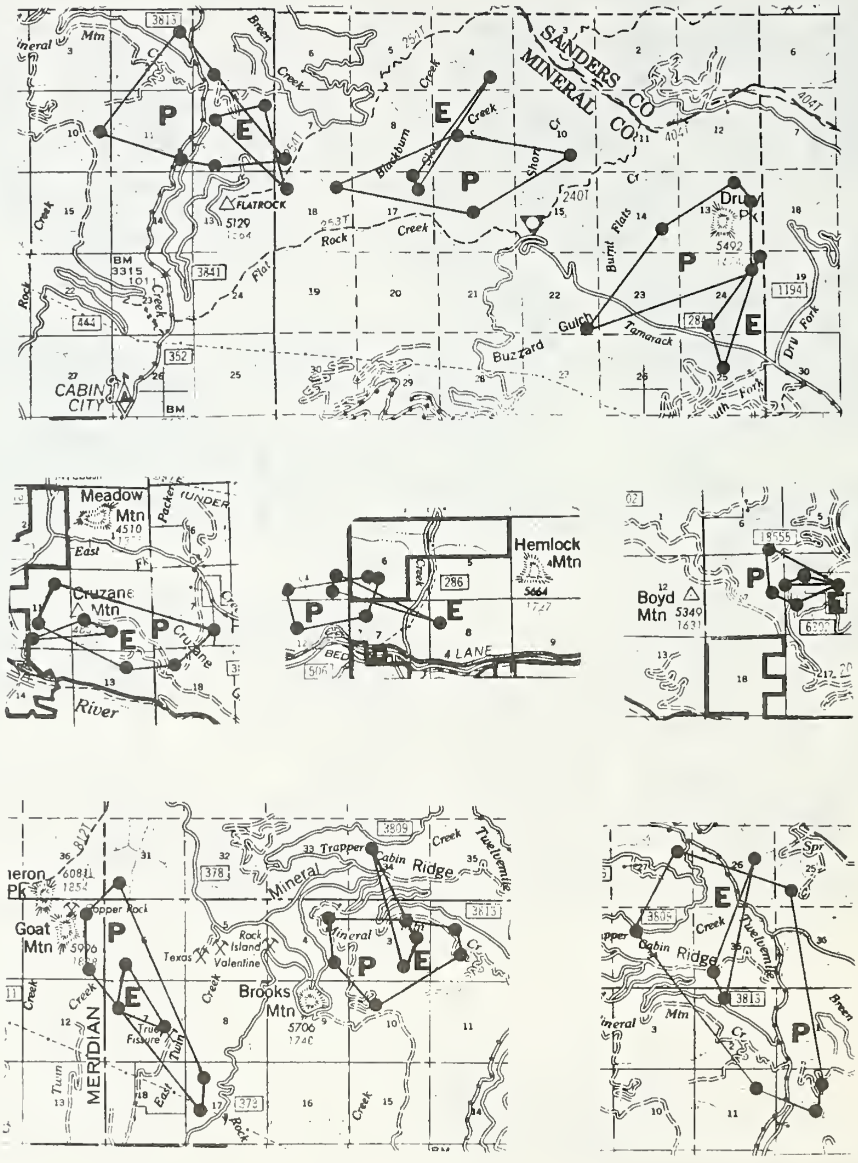


Fig. 29. Comparisons of the pre-hunting (P) and early-hunting (E) season home range polygons of 9 individual radioed elk relocated 12 times from 14 October-3 November 1986 in Montana elk hunting district 200, near DeBorgia.

reported increases in the distances between successive relocations and in home range sizes in response to hunting pressure.

It was not assumed that the distances between successive relocations and the actual distances moved by elk between relocation flights were similar or correlated. Canfield (1984:50-54) reported that a typical elk on the North Boulder, Montana, winter range moved 1-2 km at about 4-6 hour intervals, and that these movements often were not in the same direction. Lonner and Hammond (1980:24) also reported that elk were "active and constantly on the move" on the Long Tom Creek summer range in Montana. Therefore, it was possible for a radioed elk to move as far (or farther) between identical daily relocations as between widely divergent daily relocations. Similarly, it was not assumed that the home range polygons were accurate representations of the actual seasonal home ranges of radioed elk, since undocumented movements between relocation flights could have occurred outside the observed home range boundaries.

It was not necessary to make these assumptions, however, in order to conclude that the movement patterns of 12 radioed elk changed coincident with the opening of hunting season. The home range polygons and the distances between successive relocations recorded in pre-hunting season indicated markedly consistent patterns in elk movements that changed abruptly with the opening of the hunting season. Further, the hunting pressure associated with early hunting season was the event that most likely caused the abrupt changes in elk movement patterns. Weather conditions were similar throughout the pre-hunting and early hunting seasons; hence, there was no reason to suspect that weather influences or associated habitat selection factors caused such abrupt changes.

Distances to the powerline and open roads (measured from the closest pre-hunting season relocation), and sex- and age-classes of radioed elk did not differ significantly ($P > 0.40$) between the 12 affected elk (those that displayed a distributional response to the opening of hunting season) and the 16 unaffected elk (Table 1). Mean closest distances to the powerline and to open roads were 2.0 km (S.D. = 1.4) and 0.4 km (S.D. = 0.4), respectively, for affected elk, and 2.2 km (S.D. = 1.7) and 0.4 km (S.D. = 0.5), respectively, for unaffected elk. Mean age-classes (all elk $\geq$ 4-years-old were assigned an age of 4) of affected and of unaffected elk were 2.9 yr (S.D. = 1.0) and 3.2

Table 1. Characteristics of radioed elk that displayed a distributional response to the opening of hunting season compared with characteristics of those elk that did not in Montana elk hunting district 200 in 1986.

Elk Type			Elk Location (Pre-hunting)		
				Distance (km) to	
I.D.	Sex	Age	Landmark	Powerline	Open Road
0437[a]	F	3	Tamarack Hill	0.5	0.0
1211[a]	F	3	Cruzane Mtn.	2.3	0.5
1563[a]	F	4+	Taft Peak	3.3	0.0
1286[b]	F	6+	Taft Peak	3.3	0.0
0620[b]	F	4+	Taft Peak	2.6	0.3
1110[b]	F	2	Cruzane Mtn.	2.5	0.5
0942[b]	F	3+	Cruzane Mtn.	1.0	0.0
1489[c]	F	3	Flat Rock Cr.	1.3	0.9
0429[c]	F	4+	Buzzard Gul.	0.0	0.5
0716[c]	F	2	Boyd Mtn.	4.0	0.8
1467[c]	M	1	Buzzard Gul.	0.0	1.0
1164[c]	M	2	Sesame Cr.	3.2	0.5
0280	F	2	Drury Peak	1.2	0.0
1712	F	3	Twelvemile Cr.	3.4	0.0
1584	F	2	Breen Cr.	2.8	0.0
0542	F	4+	Slow Cr.	3.1	0.9
1453	F	4+	Middle Rock Cr.	0.0	0.0
0978	F	4	Mineral Mtn. Cr.	3.2	0.0
0606	F	4+	Mineral Mtn. Cr.	5.2	0.0
1098	F	4+	Twelvemile Cr.	4.3	0.0
0879	F	4+	Boyd Mtn.	4.0	0.6
0475	F	2	Goat Mtn.	1.8	0.7
0765	F	4+	Tarbox Hill	0.5	0.4
0812	F	8+	Hemlock Mtn.	0.0	0.4
1317	F	2	Taft Peak	3.1	0.3
1214	M	2	Cruzane Mtn.	2.5	0.5
1360	M	2	Goat Mtn.	0.0	0.4
1539	M	6+	Flat Rock Cr.	0.0	1.7

[a]Distances between successive relocations were longer in hunting season than before hunting season, but home range polygons before and during hunting season overlapped.
[b]Distances between successive relocations were longer in hunting season than before hunting season, and home range polygons before and during hunting season were disjunct.
[c]Distances between successive relocations were similar before and during hunting season, but home range polygons before and during hunting season were disjunct.

yr (S.D. = 1.0), respectively. The ratio of bulls:cows was 2:10 for affected elk and 3:13 for unaffected elk.

Radioed elk, on the average, were relocated $\geq$ 2 km from the powerline in pre-hunting season. The known pre-hunting season ranges of only 21% of the radioed elk (6 of 28) crossed a portion of the powerline corridor; 2 of these were part of the affected elk group and 4 were unaffected (Table 1). Both of the affected elk were near Buzzard Gulch (located east of the Middle Rock Creek study zone at the head of Tamarack Creek), which indicated that hunting pressure probably was particularly concentrated in this drainage in early-hunting season. Otherwise, the powerline project did not appear to contribute directly to the distributional responses of elk observed in this analysis.

The distances from pre-hunting season polygons to open roads did not explain the observed distributional responses of elk to hunting pressure. Open roads were included within the boundaries of the pre-hunting season polygons of 7 unaffected elk, as well as 4 affected elk (Table 1). However, the unaffected elk may have adjusted their movement patterns in a manner that was undetected by this analysis. Reductions in the sizes of daily home ranges were expected in response to hunting pressure (Edge et al. 1985), but these could not be detected conclusively in this analysis due to prohibitively small sample sizes of relocations in early-hunting season. In addition, the criterion of completely disjunct pre-hunting and early-hunting season polygons precluded more subjective interpretations of possible adjustments in elk movement patterns that were indicated by partially overlapping but divergent polygons (Figs. 28, 29). Therefore, the distributional responses to hunting pressure detected in this analysis were minimum estimates of the actual levels of elk responses. The possible undetected responses may have prevented an accurate assessment of the effects of open roads. Previous studies in western Montana have reported displacement of elk from habitats near open roads in response to hunting activity (Marcum 1975:157-158, Daneke 1980:49-52).

Although only a minimum estimate of elk reactions to hunting pressure was obtained, detection of elk responses was not limited to extreme cases. The intensity of relocation effort expended in pre-hunting season documented much of the expected variation in relocation distribution, thereby allowing detection of relatively subtle distributional responses in early-hunting season. All elk responses were detected within previously-known boundaries of

yearlong home ranges. Dispersals from yearlong home ranges would be considered extreme responses (Irwin and Peek 1979, Edge et al. 1985, Lyon et al. 1985:3-4).

The results of this analysis suggested that variables other than the powerline project, open roads, elk age, and elk sex accounted for the observed variability in elk responses. Topography, forest cover, and individual variation in elk behavior were other likely factors. However, examination of the locations of affected and unaffected elk suggested that the distribution of hunters themselves, whether on open roads, closed roads, or trails, was the most important variable that was not measured. Proximity to open roads may not be a useful indicator of actual hunting pressure if hunters exerted disproportionately high effort in some locations along the roads, but disproportionately low effort elsewhere. Hunters appeared to exert more pressure on elk on Taft Peak and Cruzane Mountain than on elk that resided along Twelvemile Creek and adjacent drainages (Table 1), although major thoroughfares for hunting traffic existed near all these locations.

Topography, forest cover, and tradition may play as much of a role in hunter distribution as in elk distribution. It is possible that hunters were able to "key-in" on prominent landscape features such as Taft Peak and Cruzane Mountain as likely places to find elk, but were unable to recognize the comparatively inconspicuous roadside habitats that occurred elsewhere. These cues used by hunters may be difficult to measure and probably are not adequately represented by the factors that are usually incorporated in models of elk habitat security. This may explain some of the variation in elk response to hunting pressure that was observed in habitats of similar apparent security levels.

The distributional responses of affected elk indicated that these elk selected habitats immediately prior to hunting season that did not provide sufficient security for them to remain there during hunting season. Irwin and Peek (1983) concluded that forage conditions and social factors were the major determinants of the sizes and locations of elk home ranges in northern Idaho. Pre-hunting season movement patterns probably represented an optimal strategy of habitat utilization when secondary habitat determinants, such as human disturbances (Irwin and Peek 1983), exerted relatively little influence. Elk that were forced to adjust their movement patterns in response to hunting

pressure were denied full access to available habitat components due to inadequate habitat security (Lyon et al. 1985:42).

The distributional responses of affected elk also suggested that these elk were potentially more susceptible to harvest than unaffected elk, if it is assumed that close-range encounters with hunters were more apt to cause elk distributional responses than more distant encounters. About 82% of the radioed elk (23 cows of 28 total) were legal game for only about 10% of the hunters afield; hence, survival of radioed elk was not a useful criterion of habitat security.

Although the radioed sample may not be perfectly representative of the entire elk population (i.e., some population units and individual behavior-types possibly were over- or under-sampled), the fact that $\geq$ 43% of the radioed elk were susceptible to the effects of hunting pressure suggested that a substantial proportion of the elk population in HD 200 was affected by limitations in habitat security in 1986. Replication of this study in 1987 will test the year-to-year consistency of habitat security relationships.

Further losses in habitat security, in combination with the current security limitations suggested by this analysis, could exert an enhanced cumulative impact (Youmans 1983, Kroodsma 1985:86, Picton et al. 1986:78) which, in turn, could lead to undesirable overharvest and a decline in public hunting opportunities (Lonner and Cada 1982, Lyon et al. 1985:4). Therefore, possible impacts of the powerline project on elk habitat security and hunting opportunity may not be manifested at this time, but could contribute over several years or decades to a cumulative impact.

The existence and magnitude of any cumulative impact will depend largely on future management plans for areas of high traditional elk use along the powerline. Some of these important elk habitats in HD 200 have been identified by this study and the LCFEP (Henderson and Lemke 1987). Strategies to maintain or enhance the security of these habitats should be part of future management plans to reduce the potential for undesirable cumulative impacts. Lonner and Cada (1982) modeled the cumulative impacts of increasing open road densities and decreasing hiding cover on elk habitat effectiveness, based on data from 25 DFWP hunting districts located east of the Continental Divide in Montana, but cautioned that the specific relationship they reported may not be as applicable west of the Divide.

Comparisons of pre-hunting season polygons for 11 radioed elk monitored in both 1985 (Thompson and Sterling 1986) and 1986 revealed remarkable year-to-year consistency, as well as marked annual variation, in habitat selection by individual elk (Figs. 30, 31). Overlapping polygons were recorded for 4 cows and 1 mature bull. Non-overlapping, but not widely-separated, polygons were recorded for another 4 cows. Widely-separated (10-18 km apart), disjunct polygons were recorded for 2 bulls that became 2-year-olds in 1986. Age or geographic location had no apparent affect on the year-to-year consistency of habitat selection by cows.

The observed variation in pre-hunting season habitat selection indicates that the susceptibility of elk to hunting pressure in the early-hunting season may vary annually, depending upon the security of the pre-hunting season habitats selected by elk in a given year. Radioed elk were not as concentrated in distribution on Taft Peak and Cruzane Mountain in 1985 as in 1986, and relatively little response by radioed elk to hunting pressure was observed in 1985 (Thompson and Sterling 1986). The observed annual variation in habitat selection also supports the conclusion of Marcum and Scott (1985:76) that evaluations of habitat security or elk distribution based on only 1 year of data may lead to erroneous conclusions.

Early-hunting season polygons also were compared for 12 elk monitored in both 1985 and 1986 (Fig. 32). Conclusions regarding year-to-year consistency of use by individual elk in this study are necessarily more subjective in early-hunting season due to low sample sizes of relocations. However, with the exception of the 2-year-old bulls, elk tended to use the same general security areas in both years. This suggests that although elk selection of pre-hunting season habitats may vary annually with variations in weather and/or forage conditions, elk selection of security cover in response to hunting pressure may be less variable. This tendency for elk to occupy the same areas of security cover year after year could make them particularly vulnerable to harvest in these habitats following roading or cover reductions (Lyon et al. 1985:4). On the positive side, however, maintenance of security levels in these traditionally-used habitats may be a powerful tool in offsetting or reducing the impacts of developments such as the powerline project or timber sales.

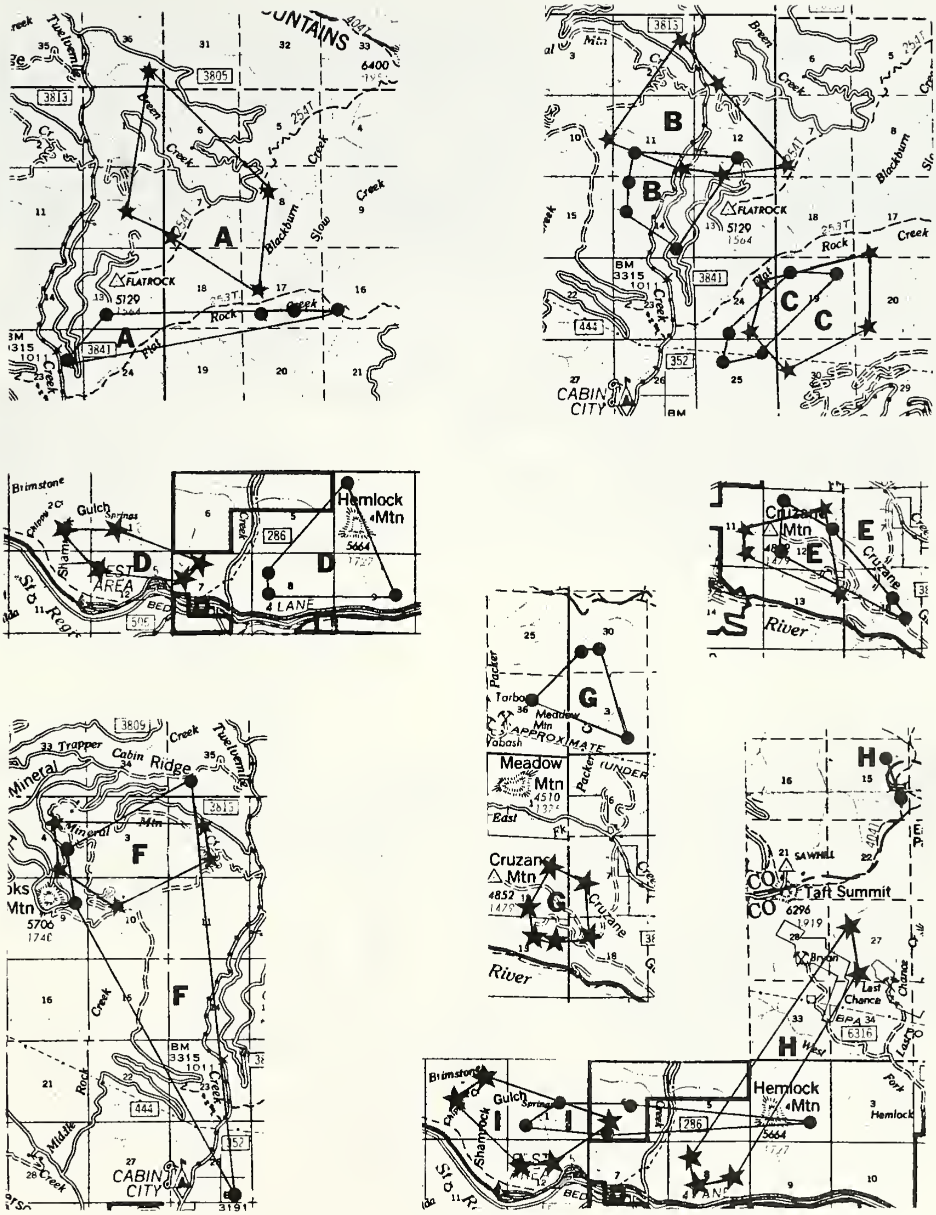
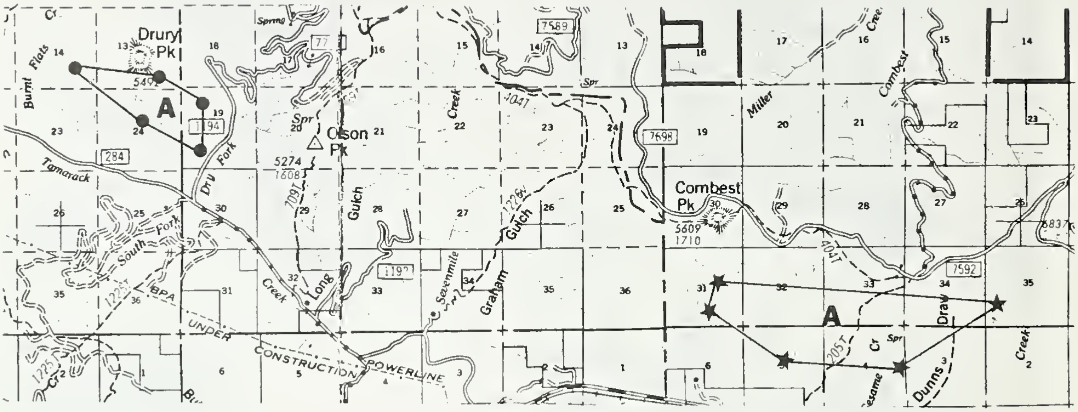


Fig. 30. Comparisons of the pre-hunting season home range polygons recorded in 1985 (dots) and 1986 (stars) for 9 individual radioed elk (labeled A-I) in Montana elk hunting district 200, near DeBorgia.



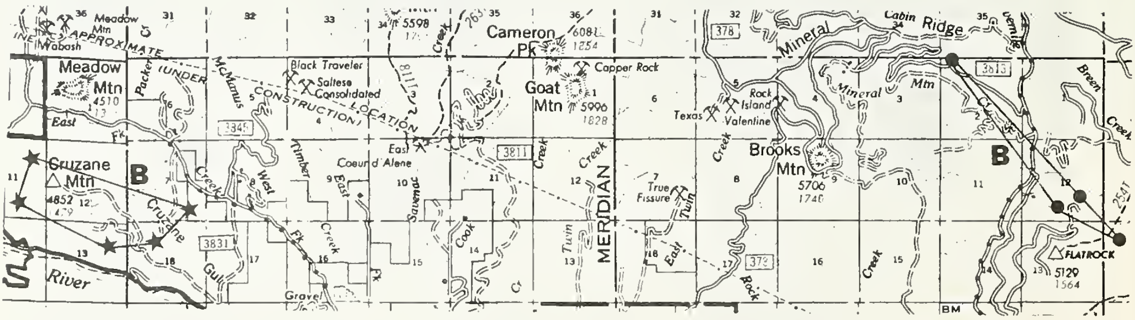


Fig. 31. Comparisons of the pre-hunting season home range polygons recorded in 1985 (dots) and 1986 (stars) for 2 individual radioed elk (labeled A and B) in Montana elk hunting district 200, near DeBorgia. Both elk were 2-yr-old bulls in 1986.

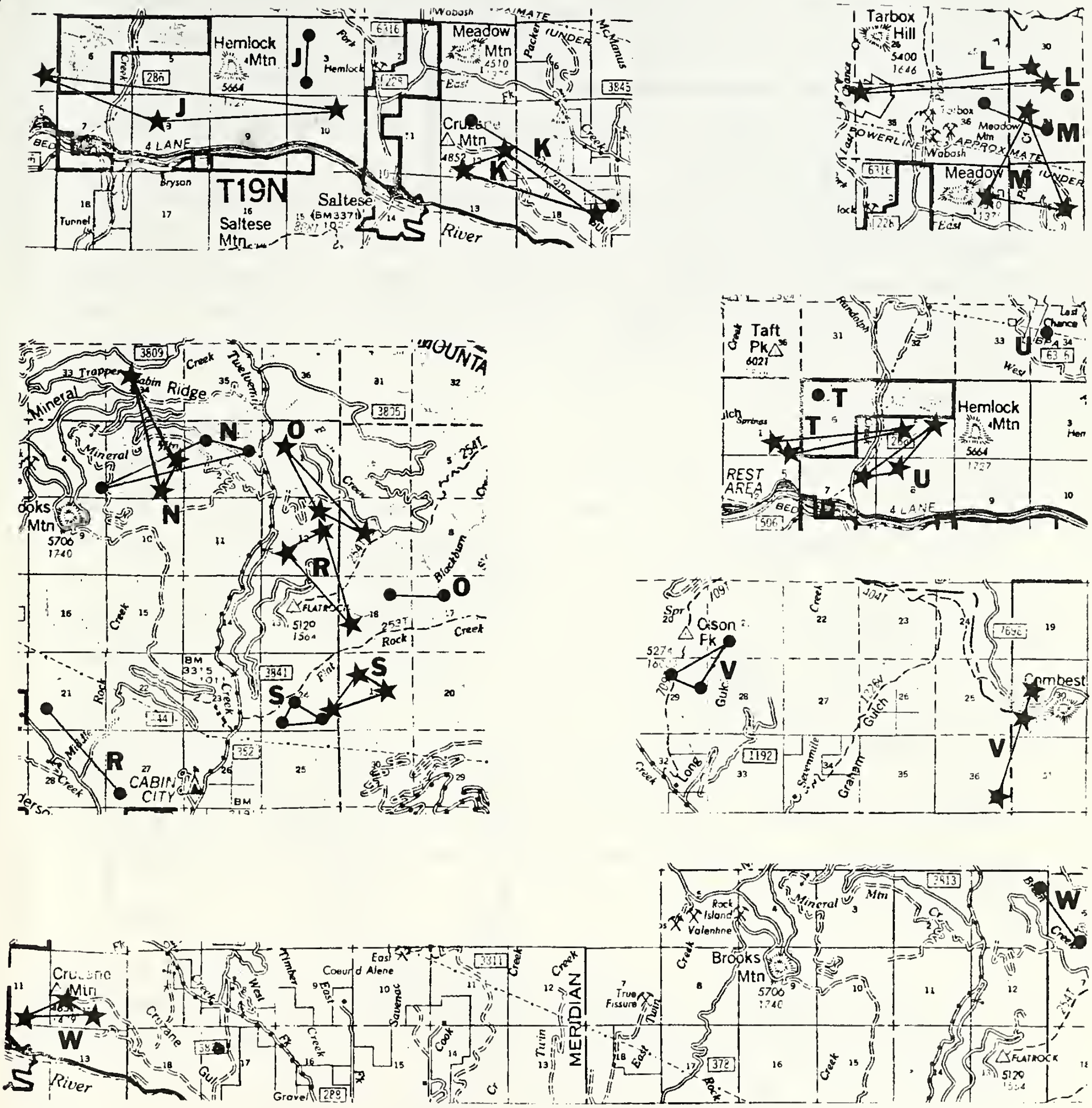


Fig. 32. Comparisons of the early-hunting season home range polygons recorded in 1985 (dots) and 1986 (stars) for 12 individual radioed elk (labeled J-W) in Montana elk hunting district 200, near DeBorgia. Elk V and W were 2-yr-old bulls in 1986.

9.4. Elk Habitat Security (HD 210): A preliminary analysis of elk habitat security in HD 210 was of limited applicability due to the small sample size of radioed elk (4). However, the pre-hunting season home ranges of 3 of the radioed elk (2 cows and a 2-year-old bull) crossed the powerline corridor and, therefore, may be useful in assessing possible powerline project impacts on habitat security (Fig. 33).

Mean distances between successive relocations did not differ markedly immediately before and after the opening day of hunting season (Fig. 34). Pre-hunting and early-hunting season polygons generally overlapped, except for 1 cow elk with disjunct polygons. It may be possible to evaluate elk habitat security in HD 210 if more elk can be captured and monitored as planned in 1987.

Two radioed cow elk were affected by land ownership and hunting pressure in contrasting ways. One that frequented the West Fork of Lower Willow Creek in pre-hunting season appeared to leave private lands just before the opening of hunting season in favor of upper elevations on adjacent National Forest lands; this pattern also was observed in 1985 (Fig. 33). This radioed elk was part of a widely-known group of elk that elicited landowner complaints, resulting in an allotment of either-sex permits by DFWP directed toward the harvest of these elk. In contrast, another radioed cow was part of a small group of elk that frequented private land along the Clark Fork River in pre-hunting season and remained there in early-hunting season (Fig. 33). The local landowner tolerated this group of about 30 elk and did not allow access to hunters; hence, these elk apparently used private land as a source of security from hunting pressure.

9.5. Trial Analysis of Relocation Distribution: This trial analysis was conducted to assist evaluation and development of a procedure to quantify the determinants of elk distribution in HD 200. The final analysis will be presented in the final study report. Specific objectives of the final analysis are: (1) to quantify the influences of selected habitat variables (including the powerline project) on elk distribution, (2) to develop models that may be used by managers to predict changes in elk distribution as habitats are altered, and (3) to assess the applicability of these models to

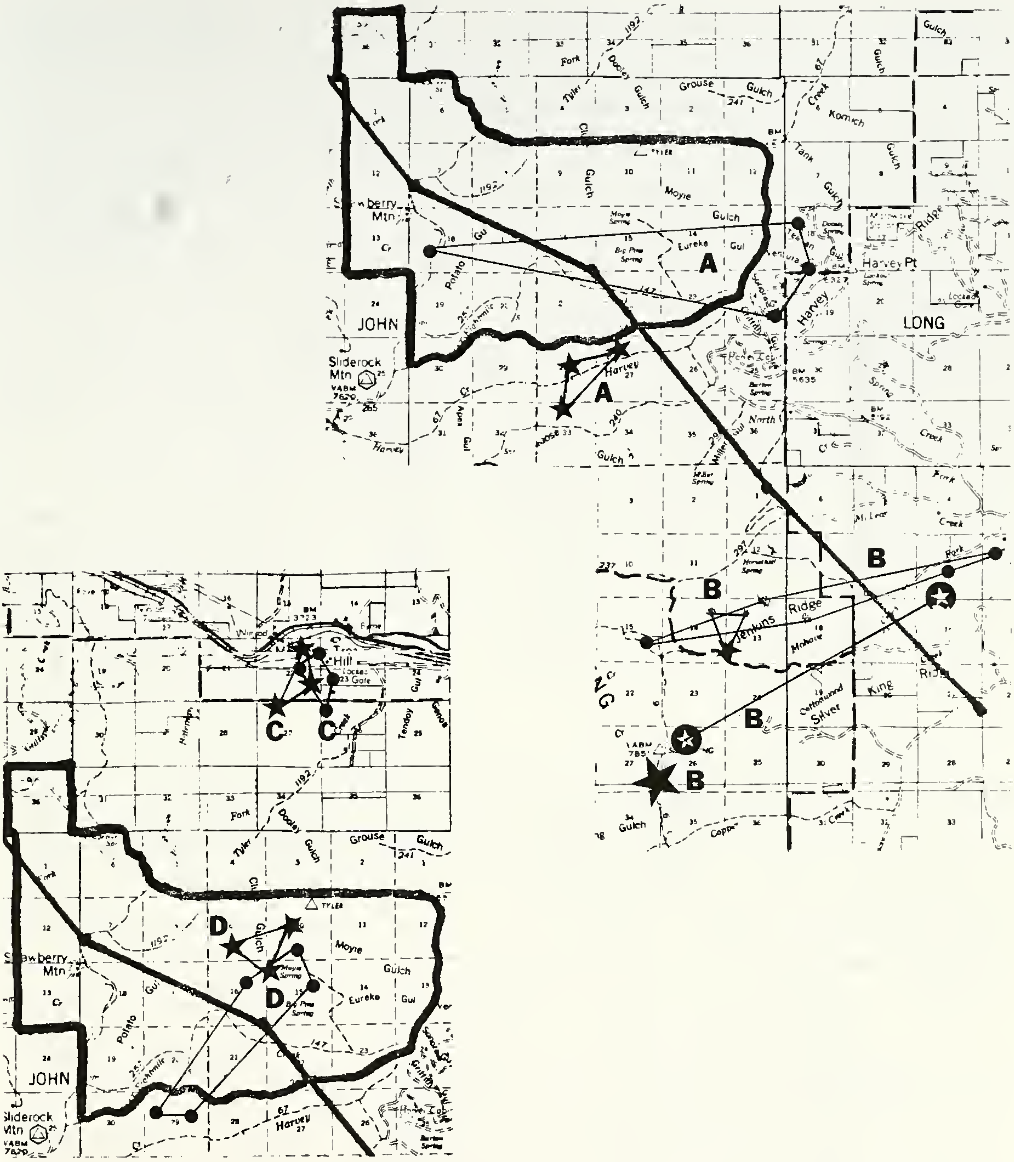


Fig. 33. Comparisons of the pre-hunting (dots) and early-hunting (stars) season home range polygons recorded in 1986 for 4 individual radioed elk (labeled A-D) in Montana elk hunting district 210, near Hall. The pre-hunting (white stars) and early-hunting (large black star) season relocations of elk B in 1985 also are depicted. The Harvey-Eightmile study area is outlined and the Garrison-Taft powerline is indicated by the thick diagonal line.

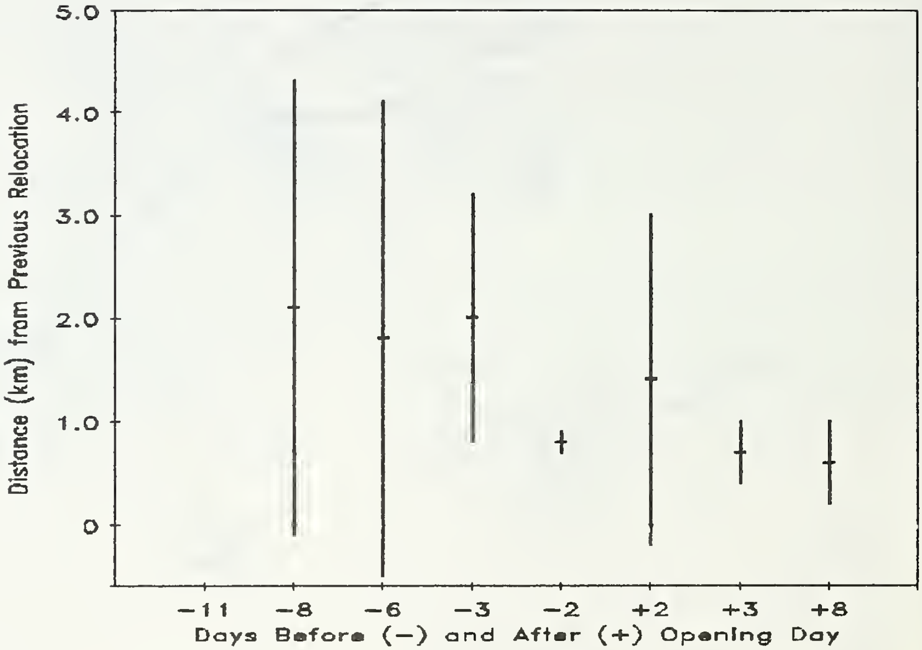


Fig. 34. Mean distances (and standard deviations) between successive relocations of 4 radioed elk immediately before and after the opening of the general elk hunting season (26 October) in Montana hunting district 210 in 1986.

elk populations outside the study area. The specific objectives of this trial analysis were: (1) to determine the extent to which elk distribution may be explained by multiple regression analysis of currently-mapped variables, (2) to identify problems in study design or analysis that must be resolved before the final analysis, and (3) to facilitate peer review and comment on the proposed analysis.

About 37% of the variation in elk distribution in pre-hunting season (as indicated by combined relocation data from 1985 and 1986 in the Twelvemile Creek drainage of HD 200) was explained by the variation in 6 habitat parameters as determined from stepwise multiple regression ($R^2 = 0.369$, $F = 18.03$, $P < 0.01$). These 6 parameters included 5 landtypes (Table 2) and an index of landtype diversity. The diversity index alone made a greater contribution to R^2 than the 5 landtypes combined (Fig. 35). Access and human disturbance variables (i.e., lengths of open roads, closed roads, new powerline access roads, trails, and the powerline corridor) were not selected by the stepwise regression procedure as important variables. The addition of these variables to the regression model resulted in an increase in R^2 of only 0.018 (Fig. 35).

Although apparently slight in consequence to overall elk distribution, negative coefficients for open roads, trails, and the powerline corridor indicated some avoidance of these features by elk. Conversely, positive coefficients indicated some selection by elk for closed roads and the new powerline access roads (most of which were closed). This is consistent with the findings of Marcum (1975) which suggested that elk avoided human activity along roads rather than the roads themselves; open roads probably received more human use than closed roads, particularly in pre-hunting season.

About 63% of the variation in elk distribution was left unexplained by this trial regression. However, it would be unrealistic to expect that the remaining variation may be explained entirely by measurable habitat variables which were not included in this analysis. Shannon et al. (1975) suggested that unexplained variation in bighorn sheep distribution may have resulted, in part, from: (1) shortcomings in the multiple regression method as a means of modeling environmental complexes, (2) traditional animal use patterns that were somewhat independent of environmental cues, and (3) the possibility that the population did not occupy all areas of equal preference due to low

Table 2. Characteristics of landtypes identified by stepwise regression analysis as important determinants of elk distribution immediately before hunting season in the Twelvemile Creek drainage of Montana elk hunting district 200 in 1985 and 1986 (landtype characteristics were taken from a draft legend provided by the Lolo National Forest, Missoula).

Landtype Code	Landform	Vegetation[a]
60.Qd	Very steep slopes adjacent to streams	GF/Libo,Clun;C/Clun
60.Qc	Very steep slopes adjacent to streams	DF/Phma-phma,Libo
64.Qd	Steep slopes not adjacent to streams	GF/Libo,Clun;C/Clun
64.Qe	Steep slopes not adjacent to streams	AF/Xete,Vagl,Mefe
30.Md	Moderately steep slopes, low ridgetops	GF/Libo,Clun;C/Clun

[a]Codes used by U. S. Forest Service for habitat types described by Pfister et al. (1977); some habitat types listed secondarily in the draft legend were not listed here, but may be important to elk.

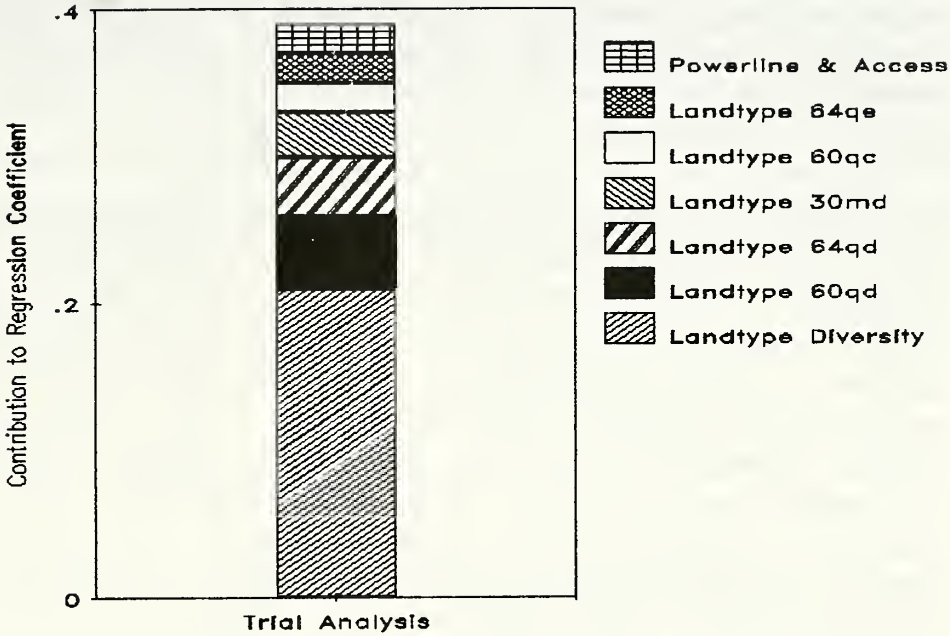


Fig. 35. Contributions to the regression coefficient (R^2) by 7 categories of independent habitat variables (as selected by stepwise regression) used to explain the variation in the distribution of elk relocations in a portion of Montana elk hunting district 200, near DeBorgia, in pre-hunting season 1985 and 1986.

population density relative to habitat fill. Previous analyses of habitat factors using multiple regression techniques have explained 65-68% of the variation in the distribution of free-ranging bighorn sheep and elk (Shannon et al. 1975, Grover and Thompson 1986); hence, it might be reasonable to expect that an additional 30% of the variation in elk distribution in HD 200 may be explained by measurement of additional environmental variables. Vegetation structure (forest canopy coverage, clearcuts, etc.) is 1 potentially important factor that should be added to the final analysis; other potentially important variables also should be considered.

Experience gained from this trial analysis indicated that delineation of the analysis unit for each regression also may influence the amount of variation that may be explained and, in turn, the applicability of the regression model. An earlier run of this analysis which pertained to about 45% more area in HD 200 resulted in a 40% reduction in R^2. The larger area included a substantial proportion of winter and transitional range which generally was unused by elk in pre-hunting season. This probably reduced the power of the analysis by introducing factors that pertained to elk selection of a seasonal range within their yearlong range; elimination of the peripheral winter and transitional range confined the analysis to an examination of factors influencing selection of the daily home range within a seasonal range. The latter level of habitat selection was more likely to be affected by the factors of interest in this study (i.e., the powerline, roads, etc.), while forage and social conditions probably were overriding influences at the former level of selection (Irwin and Peek 1983). Exclusion of other portions of the analysis unit along the periphery of the pre-hunting season range may improve the quality of analysis further if elk exist at reduced densities near the fringes of their seasonal ranges; elk populations at low densities may not be expected to use habitats in the same manner as they might at higher densities in the core of their seasonal range (Peek et al. 1982). In a previous study, Grover and Thompson (1986:467) selected the location and size of their analysis unit specifically to limit the numbers of independent variables and their ranges of variation.

Additional measures may be taken to improve the assessment of habitat influences on elk distribution. First, a separate model may be derived for each seasonal range to reduce the amount of variation that must be accounted

for in any single model. Second, a separate model may be derived for each elk population unit (i.e., elk that spend summer at Twelvemile Creek and winter near St. Regis constitute 1 population unit while elk that spend summer along Randolph Creek and winter along Prospect Creek constitute another population unit) to reduce possible influences of social factors, tradition, and differential population densities. Third, relocations may be stratified by elk sex to eliminate variation due to possible sex-specific habitat selection. Other measures also may be incorporated into the final analysis on the basis of peer review.

9.6. Preliminary Conclusions: Seasonal movement patterns of radioed elk in HD's 200 and 210 resembled movement patterns observed in 1984 and 1985, but a more complete knowledge of elk distribution was obtained by monitoring additional radioed elk in both hunting districts in 1986. A minimum of 43% of the radioed elk in HD 200 exhibited a distributional response to hunting pressure in the first 9 days of the general hunting season. This distributional response was not attributed directly to the powerline project. However, this radioed elk response suggested that a substantial proportion of the elk population in HD 200 selected habitats immediately prior to hunting season which did not provide adequate security from hunting pressure; hence, these elk were particularly susceptible to harvest in the first week of hunting season. Pre-hunting season ranges of some individual elk varied between 1985 and 1986, but use of security areas in hunting season seemed less variable. We conclude that maintenance of habitat security in areas of high traditional elk use (both near and away from the powerline project) will be necessary to mitigate for the anticipated long-term, cumulative impacts of past and future roading and cover reductions (including the powerline project) on local elk populations and hunting opportunity in HD 200. The small sample sizes of radioed elk and relocations in HD 210 precluded detailed analysis and conclusions.

10. Determine Fecal DAPA Levels

The analysis of fecal DAPA (2,6 diaminopimelic acid) levels may provide a useful index of elk nutritional responses to land or harvest management (Nelson et al. 1982). Fecal pellet groups were collected in 1984 in an attempt to assess the possible impacts of the powerline project on elk nutrition and energy budgets (Hammond et al. 1985). However, upon further review of the data collected to date and the study design necessary to draw conclusions, this task was dropped from the study plan.

11. Monitor Construction and Compliance with Mitigation Measures

Construction activities were completed in the fall of 1985; a summary of construction monitoring in 1984 and 1985 was provided in the 1985 progress report (Thompson and Sterling 1986).

Road closures were monitored in conjunction with other field activities. In addition, public reports of open gates were relayed to the appropriate land management agencies.

Road-closure gates were in place and it appeared that the responsible management agencies closed the gates during the designated closure periods. It appeared, however, that lack of effective enforcement of the road closures may be a problem that could compromise the value of some closures as mitigation measures. Violation of the closures (most notably the Harvey-Eightmile tie-through road closure) by 3- and 4-wheeled all-terrain vehicles was frequently reported during hunting season in 1985 and 1986, and may be chronic in some areas. Vandalism of gates, as well as violation of closures by people who appeared to have unauthorized keys to the locked gates, were additional problems reported by the public.

Compliance with the road closures is an important consideration in mitigating the possible impacts of the powerline project, since the effectiveness of the closures may be expected to vary roughly in proportion with the compliance rate (Leege 1984:10). Marcum et al. (1984:174) attributed the success of the Blackfoot Special Management Area (located east of Missoula, Montana) to continuous interagency efforts to explain the rationale

for the road closures to the public, and to involve the public in the decision-making process. Under these circumstances, hunters tended to police the closures themselves (Marcum et al. 1984:174).

12. Participate in Forest Service Project Planning

The project biologist participated on 3 USFS interdisciplinary (ID) teams in 1986. Two of these involved proposed timber sales along the powerline in the Superior District. The proposed sales were referred to as the Horsehead (located southeast of Superior) and Hawk-Packer (located in the Packer Creek study zone) sales. Concerns regarding elk habitat security and hunting opportunity were added to Forest Service concerns for consideration in project planning. Although the Hawk-Packer seed tree removal is located within the DeBorgia study area, activities were scheduled to eliminate conflicts with this study (Thompson and Sterling 1986:45-46).

The third ID team was formed by the Lolo National Forest to develop a long-term management strategy for the Mt. Bushnell roadless area, encompassing much of HD 200 north of (and adjacent to) the powerline project and HD 123 along the C-C Divide. The project biologist participated on this team along with DFWP biologists from Regions 1 and 2, and Forest Service personnel. DFWP participation was solicited by the Forest Service to incorporate information gained from this study and the LCFEP into the planning process. A management alternative will be selected in 1987.

In addition, input was provided to the Lolo Forest, based primarily on the results of this study, regarding the future disposition of the Twelve-Rock timber sale. Portions of this sale were located in the Middle Fork Rock Creek study zone and activities in these locations previously were deferred for the duration of this study (Hammond et al. 1985). The Forest Service review of this sale did not affect this deferrment, but pertained to the cutting units outside of the study area and activities scheduled after the study is completed. DFWP recommended that the sale be dropped, or at least rescheduled, due to the anticipated cumulative effects of past and planned timber sales on elk habitat security in the Twelvemile Creek drainage.

13. Participate in Forest Service Forest Planning Process

Study activities pertaining to this task were reported in previous progress reports (Hammond et al. 1985, Thompson and Sterling 1986).

14. Implement Road Closures Through Participation in the Forest Service Travel Planning Process

The proposed revision of the Lolo National Forest travel plan was opened to public review in 1986. Information from this study was incorporated in the comments from DFWP. Emergency road closures previously implemented by the Lolo Forest in response to the powerline project were included in the proposed travel plan. In addition, the Lolo Forest proposed an extension of the Harvey-Eightmile tie-through closure to include the West Fork of Tyler Creek and Strawberry Mountain; this was strongly supported by DFWP. The final travel plan is due in the summer of 1987.

The proposed revision of the Deerlodge National Forest travel plan is expected in early 1987.

15. Determine Project Impacts (Summary of Preliminary Results)

Impacts of the powerline project on elk may be categorized as short-term or long-term. Short-term impacts include effects of the powerline project that resulted primarily from construction activities and disturbances. These impacts typically would be expected to persist only as long as construction activities occurred, although continuing, sporadic disturbances could extend the duration of impact on elk (Lyon et al. 1985:38-39). Long-term impacts include effects resulting from the continuing presence of the powerline and associated roads; hence, the potential for these impacts would be expected to persist as long as the powerline and roads were in existence.

Analysis of elk pellet group counts relative to the powerline project indicated that summer-fall elk distribution generally was unchanged as a result of construction activities that occurred in 1984-1985. However, a

consistent, but statistically insignificant, reduction in elk use was observed within a 1-3 km band encompassing the powerline and associated road system during the hunting seasons of 1984 and 1985.

No impacts on harvest levels were detected as a result of the increased access provided to hunters by the powerline project in 1984 and 1985, although the study was not specifically designed to detect relatively subtle changes in harvest levels that may have occurred. The cover reductions and roading that occurred as a result of the powerline project contributed to a potential cumulative impact on elk habitat security and hunting opportunity; the magnitude of any such long-term impact will depend largely on future management plans for areas of high elk use.

16. Determine Magnitude of Unmitigated Impact

An assessment of unmitigated impacts could be based only on preliminary, incomplete results and interpretations at this writing; therefore, a detailed assessment was not appropriate. However, 2 unmitigated impacts of the powerline project were apparent at this stage of the study. First, the existence of the new powerline project roads facilitates timber management and increases the probability of future logging activities and cover reductions in previously-unroaded elk habitats; this represents a potential long-term, cumulative impact on elk populations and hunting opportunity that is not mitigated by public road closures. Second, the violation of public road closures by hunters, whether by vandalism of the gates, unauthorized use of keys to the gates, or circumvention of the gates by all-terrain vehicles, reduces the effectiveness of the closures as mitigation measures; this also exerts a potentially long-term impact. The magnitude of the first impact will depend on future management and the magnitude of the second impact is currently unknown, but both exist and are potentially serious.

17. Recommend Measures to Offset Unmitigated Project Impact

The following measures are recommended to offset the unmitigated impacts identified in this report. These measures are recommended for consideration at this time because implementation of these measures could affect the manner in which this study is conducted through completion.

1. Long-term, cumulative impacts of the powerline project roads may be minimized by maintaining the security of traditionally-used elk habitats in hunting season. This may be accomplished only after important habitats are identified. Mapping of security areas for future use by managers is an ongoing and important contribution of this study toward mitigation of long-term impacts in the 2 study areas. However, security areas remain unidentified along most of the powerline project from Garrison to Taft.

   Some segments of the powerline project, particularly near Missoula, were heavily-roaded previously and required little new road construction; hence, anticipated impacts of the project were relatively low in these areas (Fig. 2, Thompson and Sterling 1986:48). Conversely, the highest densities of new roads were constructed outside the study areas in the Flint Range (HD 212) and near Ellis Mountain (HD 201). Significant elk populations exist in both areas. Therefore, hunting-season security areas and fall migration routes should be identified by telemetry in these areas as a basis for long-term mitigation of potential powerline project impacts.

   Edge et al. (1986) previously recommended a relatively low-intensity plan of short duration (1-2 years) for collecting similar telemetry information pertinent to timber management in local areas. This recommendation also follows interagency guidelines for managing elk security areas relative to timber management in western Montana (U.S.D.A. et al. 1985:7-8).

2. The U.S. Forest Service planning process results in allocations of land-units to particular management priorities. Allocations on the basis of timber management potential and critical wildlife summer and winter ranges

are common. However, the Lolo and Deerlodge National Forests do not formally recognize critical wildlife security areas in their allocations, although some security areas are included in summer or winter range allocations.

Given the importance and value of recognizing security areas in mitigating the effects of the powerline project and forest management practices on elk, a management allocation specific to critical security areas should be incorporated in the next revision of the Forest Plans. Information from telemetry studies is accumulating on both Forests to allow specific and reliable allocations in many areas. This recommendation for formal recognition of elk security in Forest planning is an extension of the findings of the Montana Cooperative Elk Logging Study (Lyon et al. 1985) and the interagency guidelines for elk-habitat/timber management in western Montana (U.S.D.A. et al. 1985).

3. Violations of road closures during the hunting season reduce the effectiveness of these closures as mitigation measures. Enforcement of these closures will always be difficult because of the large areas over which they exist. Marcum et al. (1984:173-174) attributed a successful road closure program to agency efforts geared toward public support of the closures. This suggests that violations of the road closures along the powerline project may be due to a lack of adequate public support for the closures. The extent of this possible problem is unknown, but an agency effort to solidify public support would be relatively inexpensive and could be an important measure to insure the maximum possible effectiveness of the closures.

   Therefore, a more extensive effort should be made to inform the public of the purpose for the road closures and the potential benefits the closures may offer in maintaining hunting opportunities. Personnel from this study could participate with the Forest Service and DFWP in such an effort. Personal, on-site contacts with hunters during hunting season should be emphasized.

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APPENDIX A

Relocation Maps of Radioed Elk in Harvey-Eightmile Area, 1986

Fig. 36. Summer 1986 relocations of 3 radioed elk captured in 1986 (stars) and 1 elk captured in 1984 (asterisks) near the Harvey-Eightmile study area (outlined) and Garrison-Taft powerline (black diagonal line). The summer range of 7 elk documented in 1984-1985 is depicted by the shaded area.

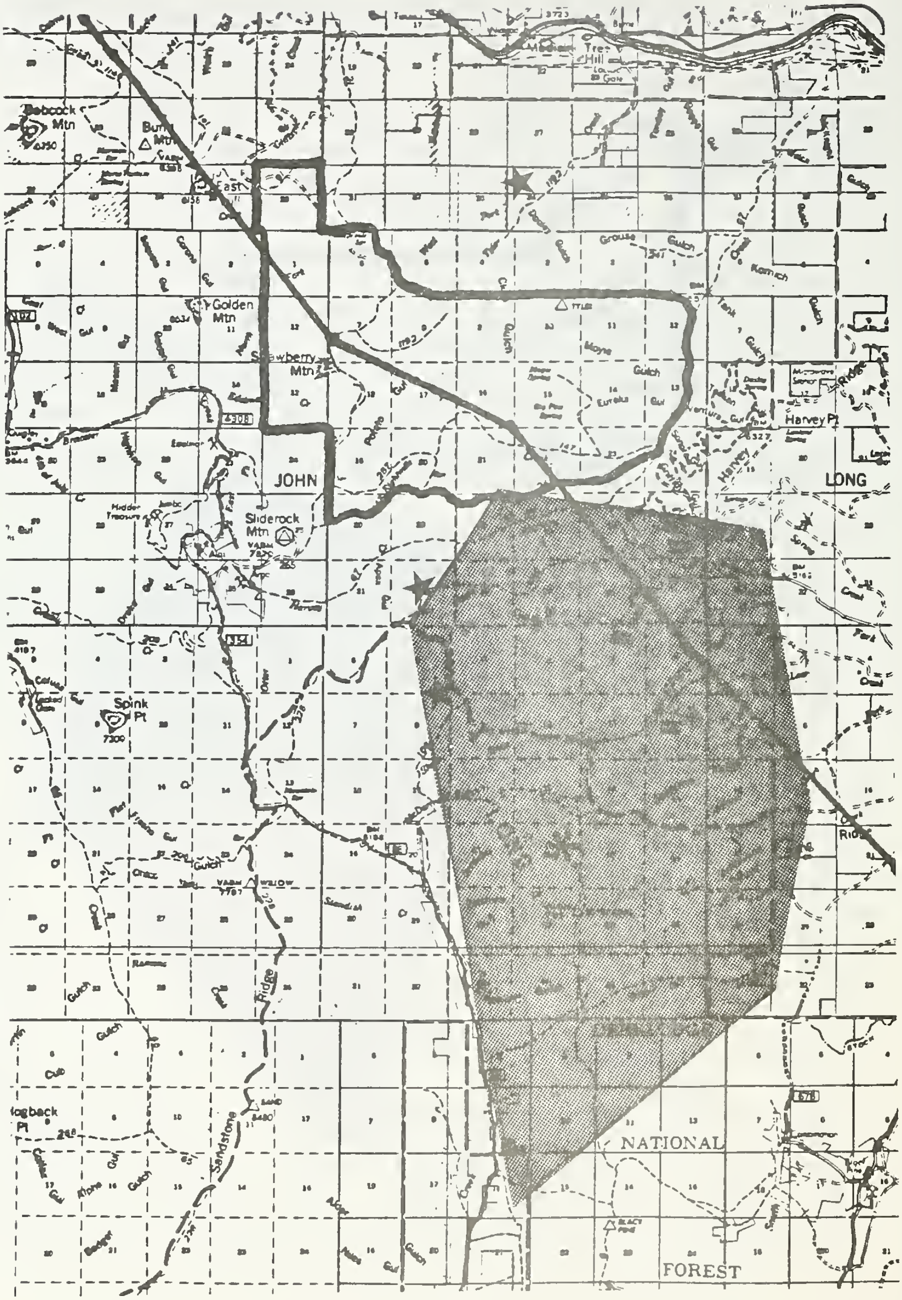

Fig. 37. Rut 1986 relocations of 3 radioed elk captured in 1986 (stars) and 1 elk captured in 1984 (asterisks) near the Harvey-Eightmile study area (outlined) and Garrison-Taft powerline (black diagonal line). The rut range of 7 elk documented in 1984-1985 is depicted by the shaded area.

Fig. 38. Pre-hunting season 1986 relocations of 3 radioed elk captured in 1986 (stars) and 1 elk captured in 1984 (asterisks) near the Harvey-Eightmile study area (outlined) and Garrison-Taft powerline (black diagonal line). The pre-hunting season range of 7 elk documented in 1984-1985 is depicted by the shaded area.

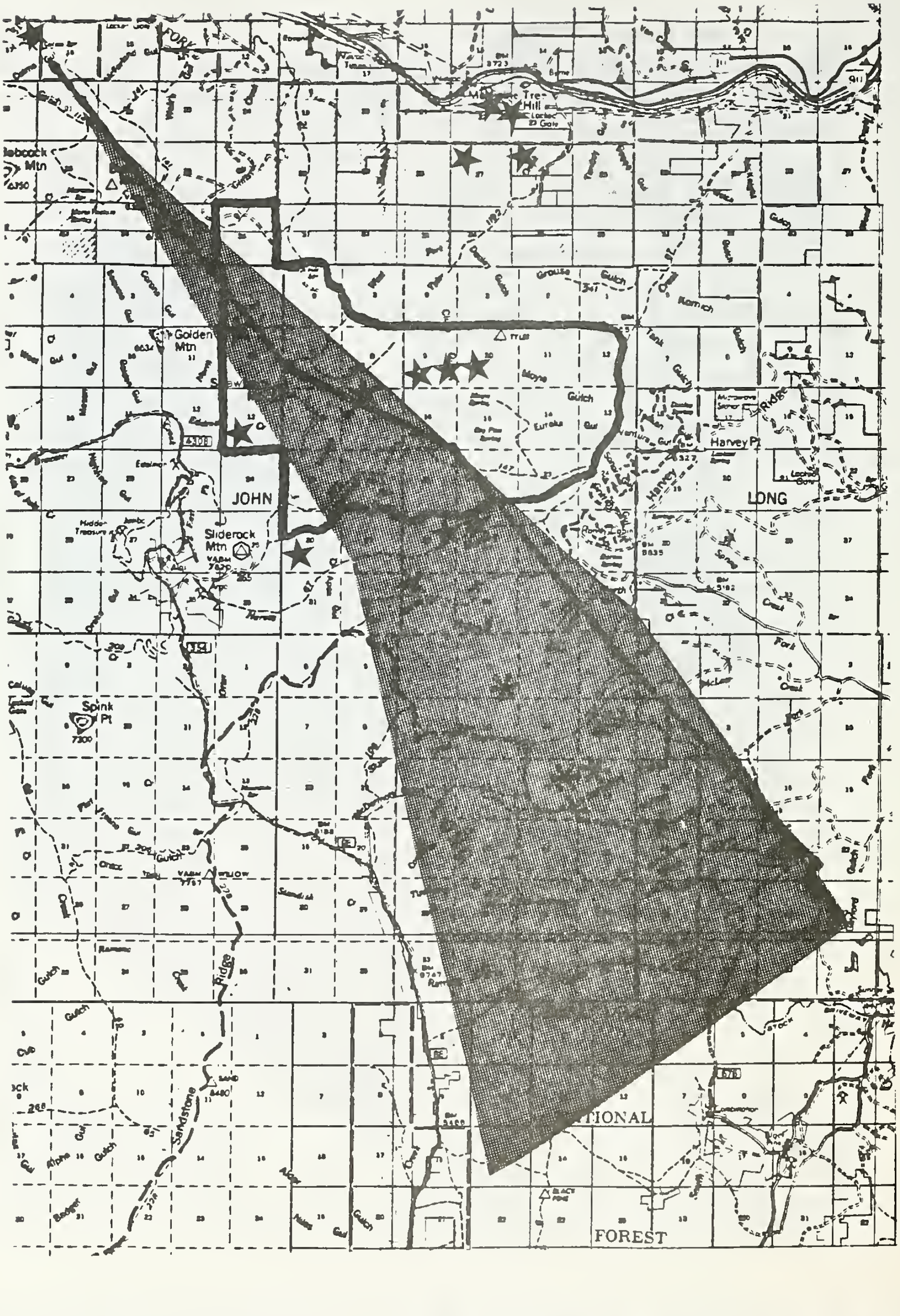

Fig. 39. Hunting season 1986 relocations of 3 radioed elk captured in 1986 (stars) and 1 elk captured in 1984 (asterisks) near the Harvey-Eightmile study area (outlined) and Garrison-Taft powerline (black diagonal line). The hunting season range of 7 elk documented in 1984-1985 is depicted by the shaded area.

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